REPORT NO. CASD-NAS-78-005

CONTRACT NO. NAS8-32702

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National Aeronautics and
Space Administration

(NASA-CR-150633) PAYLOAD PLANNING INFORMATION DEVELOPMENT STUDY Final Report (General Dynamics/Astronautics) 121 p HC A06/MF A01 CSCL 22A N78-21175 Unclas G3/12 12437

PAYLOAD PLANNING INFORMATION SHEETS DEVELOPMENT

FINAL REPORT

31 March 1978

GENERAL DYNAMICS
Convair Division

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FINAL REPORT

31 March 1978

Prepared for
GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

Prepared by
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FOREWORD

This report summarizes the results of the Payload Planning Information Sheets Development Study, which was performed by the Convair Division of the General Dynamics Corporation under Contract NAS8-32702 for the George C. Marshall Space Flight Center of the National Aeronautics and Space Administration. Convair was assisted in this study by subcontractors Kenneth Mallory and Associates of Vienna, Virginia, and Operations Research, Incorporated, of Silver Spring, Maryland.

The Contracting Officer's Representative for the study was Mr. W. R. Mixon, Code JA 61, of the Marshall Space Flight Center. Technical direction was supplied by Dr. C. J. Pellerin, Jr. and Mr. R. H. Benson, Code EI, NASA Headquarters.

The two payload planning questionnaires that were developed in this study are included in this report as Appendices A and B.

CONTENTS

1. INTRODUCTION

STUDY OVERVIEW

CUSTOMER – NASA MSFC/HEADQUARTERS

- CONTRACT NO. NAS8-32702
- STUDY C.O.R. – MR. W. R. MIXON, MSFC
- HEADQUARTERS CONTACTS – DR. C. J. PELLERIN, JR.
  – MR. R. H. BENSON

CONTRACTOR – GENERAL DYNAMICS/CONVAIR

- STUDY MANAGER – J. D. PETERSON

SUBCONTRACTORS

- KEN MALLORY & ASSOCIATES
- OPERATIONS RESEARCH INC.

STUDY SCHEDULE

- INITIATED – AUGUST 1977
- DURATION – $7\frac{1}{2}$ MONTHS

STUDY OBJECTIVES

DEVELOP PAYLOAD PLANNING INFORMATION SHEETS THAT:

- ARE EASY TO UNDERSTAND
- ARE EASY TO COMPLETE
- REQUIRE MINIMUM EFFORT BY INFORMATION SUPPLIERS

BACKGROUND

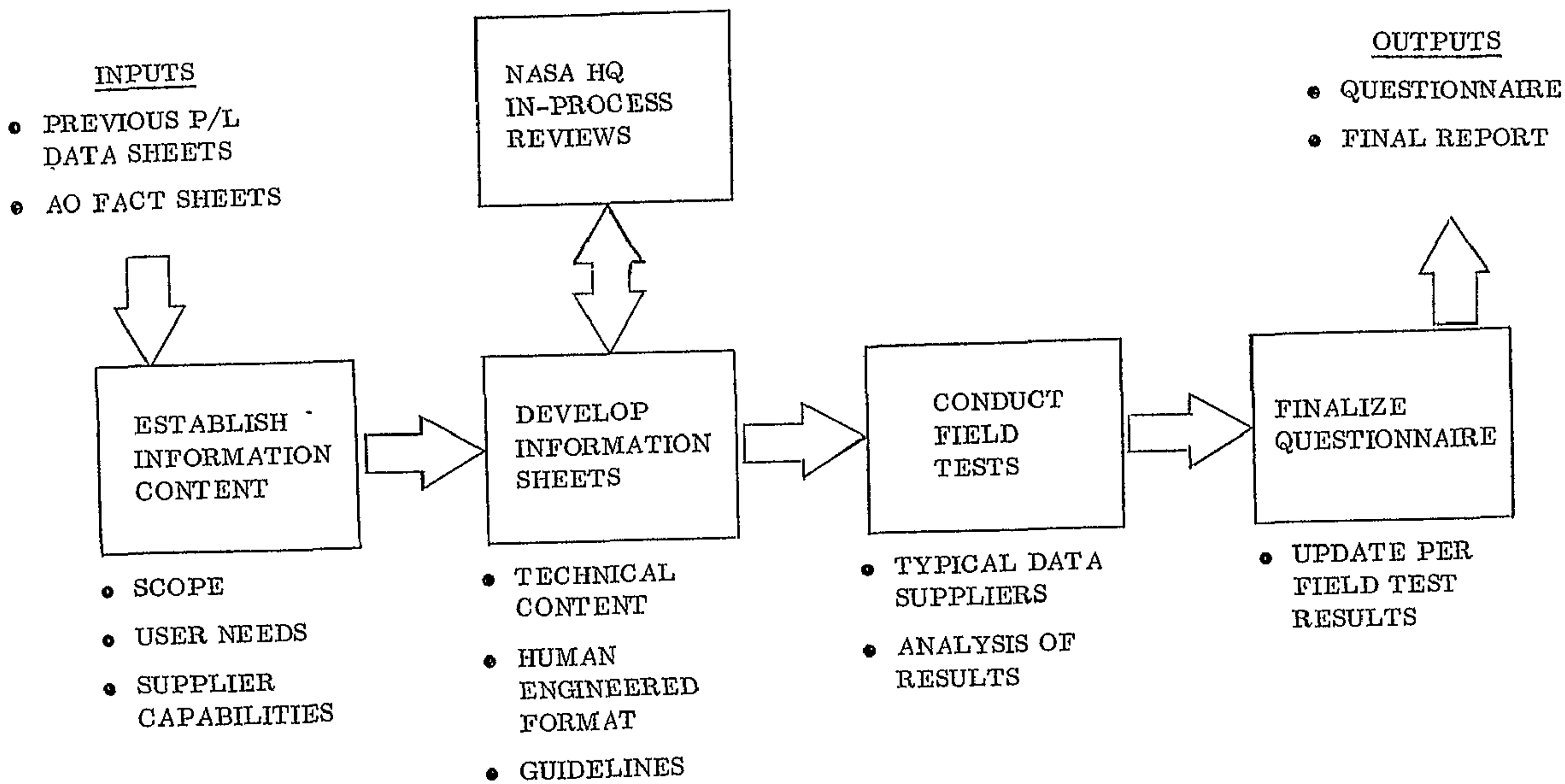
- SHUTTLE PAYLOAD DATA SHEETS HAVE UNDERGONE CONTINUOUS EVOLUTION OVER THE PAST 5 YEARS
- 1973 THRU 1975 - SPDA LEVEL A/B
  - CONTENTS DICTATED BY DATA USERS (VIA SYSTEMS WORKING GROUP)
- 1976 AND 1977 - PAYLOAD DATA INPUT FORMS
  - FORMAT DICTATED BY DATA BANK (CODING FOR DIRECT INPUT)
- TOO DEMANDING ON DATA SUPPLIERS
  - POOR RESPONSE TO REQUESTS FOR DATA
- NEW APPROACH REQUIRED
  - BETTER BALANCE BETWEEN USER NEEDS AND SUPPLIER CAPABILITIES

2. STUDY TASKS

NEW APPROACH

- USE A SELF-CONTAINED QUESTIONNAIRE
  - EASILY UNDERSTOOD & COMPLETED
- DEVELOP A "HUMAN ENGINEERED" FORMAT
  - FOLLOW PROGRAMMED INSTRUCTION PRINCIPLES
  - PROVIDE DESCRIPTIONS OF STS CAPABILITIES TO ASSIST DATA SUPPLIERS
  - USE MULTIPLE CHOICE TYPE RESPONSE WHEN POSSIBLE
- LIMIT THE LEVEL OF DETAIL
  - JUST ENOUGH TO "SURFACE" CANDIDATE PAYLOADS
  - SUPPORT LIMITED COMPATIBILITY ANALYSIS
  - BUT, ACCOMMODATE ADDITIONAL DETAILS, IF AVAILABLE
- KEEP DATA PACKAGE VOLUME SMALL
  - TIME GOAL OF ONE TO TWO HOURS, OR LESS

STUDY FLOW


INPUTS
• PREVIOUS P/L DATA SHEETS
• AO FACT SHEETS
NASA HQ IN-PROCESS REVIEWS
OUTPUTS
• QUESTIONNAIRE
• FINAL REPORT
ESTABLISH INFORMATION CONTENT
DEVELOP INFORMATION SHEETS
CONDUCT FIELD TESTS
FINALIZE QUESTIONNAIRE
• SCOPE
• USER NEEDS
• SUPPLIER CAPABILITIES
• TECHNICAL CONTENT
• HUMAN ENGINEERED FORMAT
• GUIDELINES
• TYPICAL DATA SUPPLIERS
• ANALYSIS OF RESULTS
• UPDATE PER FIELD TEST RESULTS

NASA HQ. REVIEW RESULTS

- EXPANSION FROM ONE TO TWO BOOKLETS
- OFFER ORBIT SELECTION PARAMETERS INSTEAD OF TYPICAL ORBITS
- INCREASED LEVEL OF DETAIL
  - EXPERIMENT CONTROL
  - DATA MANAGEMENT
  - COMMUNICATIONS COVERAGE
  - MISSION DURATION
  - CONTAMINATION
  - POINTING & STABILIZATION
  - EXPT. POINTING MOUNT REQUIREMENTS
  - TARGET VIEWING
  - SIZE, WEIGHT, POWER
- DECREASED LEVEL OF DETAIL
  - FREE-FLYER INSTRUMENTS REQUIREMENTS
- DISCLAIMER RE. FUNDING APPROVAL, FLIGHT ASSIGNMENT, ETC.
- EVA TRADE-OFFS
  - REDUCED EQUIPMENT COMPLEXITY, V. S. INCREASED CREW TIME

FORMAT GUIDELINES

- EACH ITEM SHOULD CONTAIN THREE PARTS –
  - A STATEMENT OF A SPECIFIC STS CAPABILITY
  - A QUESTION CONCERNING THE RESPONDENT'S NEED FOR THE CAPABILITY
  - A RESPONSE OR ANSWER BLOCK
- EMPLOY BRANCHING TO GUIDE RESPONDENTS AROUND TOPICS THAT ARE NOT PERTINENT TO THEM
- AVOID CROSS REFERENCING BETWEEN QUESTIONS
- THERE MUST BE NO REQUIREMENT TO USE STS REFERENCE DOCUMENTS (I.E., THE QUESTIONNAIRE MUST BE SELF-CONTAINED)
- EACH QUESTIONNAIRE ITEM SHOULD BE CONTAINED IN ITS ENTIRETY ON A SINGLE PAGE
- LINE WIDTH SHOULD BE LIMITED TO 3 INCHES TO IMPROVE READING SPEED AND COMPREHENSION

3. STUDY RESULTS

QUESTIONNAIRE FORMAT

- BOOKLET 1 FOR INSTRUMENTS/EXPERIMENTS (SEE APPENDIX A)
  - MAJOR BRANCHES FOR SPACELAB AND FREE-FLYER ACCOMMODATIONS
- BOOKLET 2 FOR SHUTTLE PAYLOAD ELEMENTS (SEE APPENDIX B)
  - MAJOR BRANCHES FOR ATTACHED AND FREE-FLYING PAYLOADS

BOOKLET 1 – INSTRUMENTS/EXPERIMENTS

CONTENTS

25 PAGES

BOOKLET 1 - INTRODUCTION

- PURPOSE OF QUESTIONNAIRE
  - OBTAIN LIMITED AMOUNT OF GENERAL PLANNING INFORMATION ON INSTRUMENTS/EXPERIMENTS
  - MINIMUM OF TIME & EFFORT REQUIRED
  - PLANNING FOR PERIODIC UPDATE
- STS DESCRIPTION - VERY GENERAL
  - SHUTTLE
  - SPACELAB
  - UPPER STAGES
- GENERAL INSTRUCTIONS
  - ADD ANY ADDITIONAL INFORMATION NEEDED IN NOTES OR AS SUPPLEMENTARY INFORMATION
  - HANDWRITTEN RESPONSES ARE SATISFACTORY

BOOKLET 1 - EXPERIMENT OBJECTIVES AND DESCRIPTION

- EXPERIMENT OBJECTIVES
  - NARRATIVE TYPE ENTRY
  - UP TO 8 LINES OF TEXT
- EXPERIMENT DESCRIPTION
  - NARRATIVE TYPE ENTRY
  - UP TO 10 LINES OF TEXT
- REMINDER OF OPPORTUNITY TO ADD SUPPLEMENTARY INFORMATION
- INSTRUCTIONS FOR PROCEEDING TO FOLLOWING SECTIONS

BOOKLET 1 - FLIGHT REQUIREMENTS - SPACELAB INSTRUMENTS/EXPERIMENTS

1. CREW TIME
2. EXPERIMENT CONTROL
3. MISSION DURATION
4. EXTRAVEHICULAR ACTIVITIES (EVA)
5. DATA MANAGEMENT
6. COMMUNICATION COVERAGE
7. REMOTE MANIPULATOR ARMS
8. INSTRUMENT ORIENTATION/TARGETS
9. SHUTTLE POINTING AND STABILIZATION
10. EXPERIMENT POINTING MOUNTS
11. INSTRUMENT MASS
12. POINTING STABILITY
13. EPM POINTING ACCURACY
14. CONTAMINATION SENSITIVITY
15. CONTAMINATION GENERATION
16. DESIRED ORBIT PARAMETERS
17. RADIATION
18. ACCELERATION LEVEL
19. AMBIENT PRESSURE
20. EARTH OBSERVATIONS
21. DAY/NIGHT CYCLE
22. FLIGHT SCHEDULING
23. EXPERIMENT ACCOMMODATIONS
24. EQUIPMENT WEIGHT AND VOLUME (PRESSURIZED AREA)
25. ELECTRICAL POWER (PRESSURIZED AREA)
26. SCIENTIFIC AIRLOCK
27. OPTICAL WINDOW
28. EQUIPMENT SIZE (UNPRESSURIZED AREA)
29. EQUIPMENT WEIGHT (UNPRESSURIZED AREA)
30. ELECTRICAL POWER (UNPRESSURIZED AREA)
31. EXPERIMENT AVAILABILITY
32. EXPERIMENT REFLIGHT

16 PAGES

BOOKLET 1 - FLIGHT REQUIREMENTS - FREE-FLYING SATELLITE INSTRUMENTS

This section asks a few very general questions about your satellite-borne instrument that will identify it to NASA mission planners as a candidate for future flight opportunities.

- CONTAINS BRIEF DESCRIPTION OF THE LDEF AND MMS

Please indicate below the type(s) of free-flying satellite that is a potential carrier for your instrument or experiment.

- NO DETAILED TECHNICAL QUESTIONS ARE ASKED

( ) LDEF

( ) MMS
  ( ) Low earth orbit
  ( ) Geosynchronous orbit
  ( ) Other - Explain in "Notes"

( ) Interplanetary spacecraft

( ) Other: ____________________
____
____

The information furnished in this questionnaire will be forwarded to the appropriate Program Office. You will be notified of forthcoming flight opportunities that may be appropriate for your instrument.

- FORMAL CONTACT WOULD BE ESTABLISHED BY ANNOUNCEMENT OF OPPORTUNITY

BOOKLET 1 - SUPPLEMENTARY INFORMATION

This section is provided for you to add information that is important for a better understanding of your instrument or experiment.

INVITES ADDITIONAL INFORMATION THAT DOES'NT FIT IN FIXED FORMAT OR THAT PROVIDES MORE DETAILS

Please check (✓) the type of supplementary information you have attached to this questionnaire.

CHECKLIST SERVES BOTH AS A MEMORY-JOGGER AND AS AN INDEX TO INFORMATION APPENDED

( ) Sketches, drawings, photographs
( ) Instrument/experiment data sheets
( ) Block diagrams or flow charts
( ) Reference documents or reports
( ) List of reference documents
( ) List/description of mission or accommodation requirements that cannot be compromised
( ) Target list for earth or celestial observations
( ) Description of observational times for earth observations
( ) Other descriptive information is provided on page E-2
( ) No supplementary information is furnished at this time.

Page E-2 provides space for any explanatory text you care to add.

PROVIDES FOR NARRATIVE TYPE ENTRY - UP TO 22 LINES

BOOKLET 2 – SHUTTLE PAYLOAD ELEMENTS

CONTENTS

30 PAGES

BOOKLET 2 - FLIGHT EQUIREMENTS

ATTACHED PAYLOADS

1. CREW TIME
2. PAYLOAD CONTROL
3. MISSION DURATION
4. EXTRAVEHICULAR ACTIVITIES (EVA)
5. DATA MANAGEMENT
6. COMMUNICATION COVERAGE
7. REMOTE MANIPULATOR ARMS
8. PAYLOAD ORIENTATION/TARGETS
9. ORBITER POINTING AND STABILIZATION
10. EXPERIMENT POINTING MOUNTS
11. INSTRUMENT MASS
12. POINTING STABILITY
13. EPM POINTING ACCURACY
14. CONTAMINATION SENSITIVITY
15. CONTAMINATION GENERATION
16. DESIRED ORBIT PARAMETERS
17. RADIATION
18. ACCELERATION LEVEL
19. AMBIENT PRESSURE
20. EARTH OBSERVATIONS
21. DAY/NIGHT CYCLE
22. FLIGHT SCHEDULING
23. PAYLOAD ACCOMMODATIONS
24. EQUIPMENT WEIGHT AND VOLUME (PRESSURIZED AREA)
25. ELECTRICAL POWER (PRESSURIZED AREA)
26. ELECTRICAL POWER (UNPRESSURIZED AREA)
27. PAYLOAD ELEMENT WEIGHT (UNPRESSURIZED AREA)
28. PAYLOAD SIZE (UNPRESSURIZED AREA)
29. PAYLOAD AVAILABILITY
30. PAYLOAD REFLIGHT

14 PAGES

FREE-FLYING PAYLOADS

1. NUMBER OF PAYLOADS
2. DESIRED ORBIT PARAMETERS
3. ORBITAL INCLINATION
4. OPERATIONAL ALTITUDE
5. HIGH ALTITUDE SATELLITES
6. INTERPLANETARY MISSIONS
7. SELF-CONTAINED PROPULSION SYSTEM
8. SATELLITE/SPACECRAFT SIZE
9. SATELLITE/SPACECRAFT WEIGHT
10. PAYLOAD DEPLOYMENT
11. OPERATIONAL LIFE
12. ON-ORBIT SERVICING
13. PAYLOAD RETRIEVAL/REUSE
14. EXTRAVEHICULAR ACTIVITIES (EVA)
15. REMOTE MANIPULATOR SERVICING
16. CREW TIME
17. DATA MANAGEMENT
18. PAYLOAD CONTROL
19. COMMUNICATION COVERAGE
20. *FLIGHT SCHEDULING*
21. PAYLOAD REPLACEMENT
22. PAYLOAD AVAILABILITY

9 PAGES

TYPICAL QUESTION FORMAT

ELECTRICAL POWER (PRESSURIZED AREA) Experiments inside the Spacelab module will share continuous electrical power in the range of 2.0 to 2.5 kW. Electrical service will be both DC (28 volt) and AC (115/200 volt, 400 Hz, 3 phase).	STATEMENT OF A SHUTTLE/SPACELAB CAPABILITY
Please check (✓) the range of electrical power consumption (total DC and AC) for operating your experiment equipment in the Spacelab module.	QUESTION CONCERNING RESPONDENT'S NEED
( ) None ( ) <100 watts ( ) 100-500 watts ( ) >500-1000 watts ( ) >1000-2500 watts ( ) >2500 watts - Explain in "Notes"	MULTIPLE-CHOICE ANSWER BLOCK
Or, estimate power, if possible: ____________ watts	SPACE FOR A DISCRETE ENTRY, IF DATA IS AVAILABLE

FORMAT EXAMPLES

- RANGES OF VALUES SELECTED FOR MULTIPLE CHOICE SCALAR QUESTIONS ARE RELATED TO SHUTTLE/SPACELAB ACCOMMODATION CAPABILITIES.

EQUIPMENT WEIGHT (UNPRESSURIZED AREA)

The total weight for all equipment and provisions needed to conduct experiments (including the Spacelab, experiment equipment and other support equipment) cannot exceed 14,514 kg (32,000 lb) at landing.

One spacelab pallet can carry up to 3000 kg (6,615 lb) of equipment, and a two or three pallet train can carry up to 5000 kg (11,025 lb).

Please check (✓) the total weight range of your experiment equipment which is to be mounted on Spacelab pallets (including consumables, but excluding Spacelab equipment weight).

( ) None
( ) <100 kg (220 lb)
( ) 100-500 kg (1,102 lb)
( ) >500-3000 kg (6,615 lb)
( ) >3000-5000 kg (11,025 lb)
( ) >5000 kg - Explain in "Notes"

ELECTRICAL POWER (UNPRESSURIZED AREA)

The Orbiter's electrical network can provide 7kW of DC power to the cargo bay. Spacelab subsystems, when operating, consume from 1.6 to 4.4 kW.

Equipment on the Spacelab pallet will share continuous electrical power in the range of 1.5 to 4.5 kW. Electrical service will be both DC (28 volt) and AC (115/200 volt, 400 Hz, 3 phase).

Please check (✓) the range of electrical power (total DC and AC) to be supplied by the Shuttle/Spacelab electrical distribution networks for operating your experiment equipment in the cargo bay.

( ) None
( ) <100 watts
( ) 100-300 watts
( ) >300-1500 watts
( ) >1500-4500 watts
( ) >4500-7000 watts
( ) >7000 watts - Explain in "Notes"

- "TALL-POLE" REQUIREMENTS CAN BE ACCOMMODATED TO PROVIDE THE BASIS FOR ASSESSMENT OF THE NEEDS FOR GROWTH IN STS CAPABILITIES.

TYPICAL SIMPLE QUESTIONS

ON-ORBIT SERVICING

The Shuttle can provide routine servicing or repair for satellites in low earth orbit. Is on-orbit servicing planned for your payload?

Yes ( ); No ( ); Maybe ( )

OPTICAL WINDOW

A high quality optical window that provides viewing access to earth, deep space, and the sun can be installed in the top of the module.

The window is a rectangular pane 41 x 55 cm (16.1 x 21.6 inches) with optical transmission exceeding 65% at all wavelengths between 400-1000 nm. Parallelism is maintained within 2 arc seconds.

The high quality optical window:

( ) is *not* needed by this experiment.
( ) *is* needed by this experiment.
( ) *may* be needed by this experiment.

MEDIUM COMPLEXITY QUESTIONS

EXPERIMENT CONTROL

Experiment operations can be controlled on-board, or by digital commands issued from the ground. While on-board control can be continuous, ground control will be disrupted for periods of up to 10 minutes every 25 to 40 minutes because of communications blockages.

Please check (✓) as applicable.

( ) Experiment does not require any control.
( ) Experiment requires only "on/off" commands.
( ) Experiment requires real-time active control (closed-loop).

If real-time active control *is* required, there are several methods by which it can be accomplished.

Please check (✓) the applicable method(s).

( ) By on-board crew
( ) By on-board computer
( ) By digital command from ground.

PAYLOAD RETRIEVAL

The Shuttle can be used to retrieve satellites from low earth orbit and return them to earth for refurbishment and reuse.

Is retrieval planned for your payload?

Yes ( ); No ( ); Maybe ( )

If retrieval is, or might be planned, would the same payload be refurbished for subsequent reflight?

Yes ( ); No ( ); Maybe ( )

If your payload will, or might be retrieved and refurbished for reflight, please check (✓) below the estimated number of times the payload would be refurbished.

( ) Once
( ) Twice
( ) 3 or 4 times
( ) 5 or more times

TYPICAL COMPLEX TOPIC

DATA MANAGEMENT

Two-way communication links that carry data and voice between the Shuttle and ground stations will be maintained for 55-70% of the orbital mission. An onboard recorder can be used to store data for delayed transmission to the ground.

Down Link:
- Digital Data (≤50M bps)
- Analog & TV (≤4.2M Hz)
- Voice

Up Link:
- Digital & Command (≤2k bps)
- Voice

Spacelab data management services include a general purpose computer, a high-rate (≤32M bps) digital tape recorder (26 data tracks), and display/keyboard unit(s). The Orbiter's payload recorder can record digital (≤1 M bps) or analog (≤2 MHz) data on each of 14 tracks.

Are the standard data management capabilities sufficient for your experiment?

Yes ( ); Maybe ( ); No ( ) - Explain in "Notes"

Estimate data management requirements, if possible:

Down Link:
- Digital: No ( ); Maybe ( ); Yes ( ).
- Digital Rate:_______________bps
- Analog: No ( ); Maybe ( ); Yes ( ).
- Analog Bandwidth:___________Hz
- Television: No( ); Maybe( );Yes( ).
- Voice: No ( ); Maybe ( ); Yes ( ).

Up Link:
- Digital: No ( ); Maybe ( ); Yes ( ).
- Digital Rate:____________bps
- Voice: No ( ); Maybe ( ); Yes ( ).

On-board
- General Purpose Computer:
  No ( );Maybe ( ); Yes ( ).
- Display/Keyboard Unit:
  No ( ); Maybe ( ); Yes ( ).

Other - Explain in "Notes"

FORMAT EXAMPLES

- RESPONSE BLOCKS ALLOW FOR UNCERTAINTY

The Orbiter provides the systems and personnel needed to perform manual tasks outside the pressurized work area. Nominal resources permit two, two-man EVA's, each lasting six hours per flight.

EVA can be used for operation of equipment; deployment, positioning, retraction of booms; cargo transfer; etc.

Please check (✓) one.

( ) EVA is *not* needed for the normal operation of this payload.
( ) EVA *is* needed for the normal operation of this payload.
(✓) EVA *may* be needed for normal operation of this payload.

If possible, indicate below the orbit parameters (altitude and inclination) or range of parameters compatible with your payload.

( ) Any orbit is acceptable.
( ) Desired orbit parameters are:
Inclination -
from:__________deg
to:__________deg
Altitude -
from:__________km,
or__________n.mi.
to:__________km,
or__________n.mi.
(✓) Unknown.

ORBIT SELECTION PARAMETERS

- RADIATION LIMITS
- DRAG ACCELERATION
- AMBIENT PRESSURE
- EARTH OBSERVATIONS
  - TARGET LATITUDES
  - VIEWING TIME
  - REPETITION RATE
- DAY/NIGHT CYCLE

- With respect to your experiment:
  - ( ) Any radiation dose rate within health limits is acceptable.
  - ( ) Radiation dose rates should be minimized.
  - ( ) Exposure to high dose rates is desirable - Explain in "Notes". Include desired dose rates and class(es) of radiation, if known.

- Please check (✓) the maximum allowable background acceleration level for your experiment. (The corresponding altitude is also indicated.)
  - ( ) 3×10^{-6}g @ 250km (135 n.mi)
  - ( ) 1×10^{-6}g @ 300km (162 n.mi.)
  - ( ) 5×10^{-7}g @ 350km (189 n.mi.)
  - ( ) 1×10^{-7}g @ 425km (230 n.mi.)
  - ( ) 5×10^{-8}g @ 470km (254 n.mi.)
  - ( ) Any of the above
  - ( ) Other - Explain in "Notes"

- If solar exposure is a factor in performing your experiment or observation, please check (✓) your requirement.
  - ( ) Continuous exposure (100%)
  - ( ) Maximum exposure (75 to 100%)
  - ( ) Minimum exposure (55 to 75%)
  - ( ) A specific day/night cycle or range of cycles is desirable - Please explain in "Notes".

EXAMPLES OF BRANCHING

EARTH OBSERVATIONS

Does your experiment require viewing of phenomena or targets on the earth's surface or within the atmosphere?

(✓) No; ( ) Yes.

If not, skip to page C-10.

BRANCHING SKIPS NON-RELEVANT QUESTIONS ABOUT EARTH OBSERVATIONS - 38 LINES

INSTRUMENT ORIENTATION/TARGETS

The Orbiter can point at any desired inertial, local vertical, earth fixed, or orbital object target.

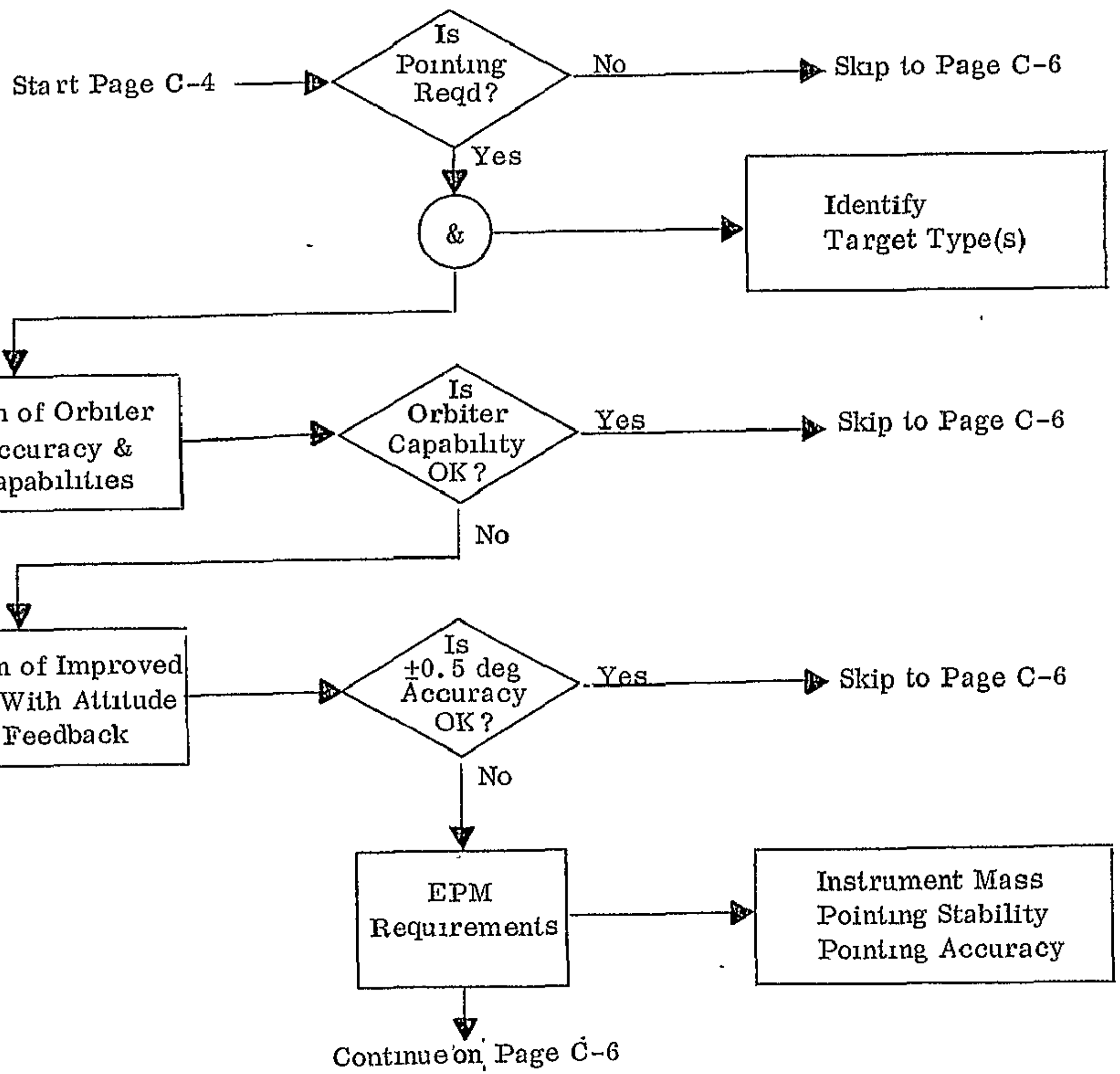
Does your experiment require instrument pointing?

(✓) No; ( ) Yes.

If not, skip to page C-6.

BRANCHING SKIPS NON-RELEVANT QUESTIONS ABOUT POINTING ACCURACY, POINTING STABILITY, EPM REQUIREMENTS - 120 LINES

POINTING & STABILITY FLOW



DATA BANK INPUT CODING EXAMPLES

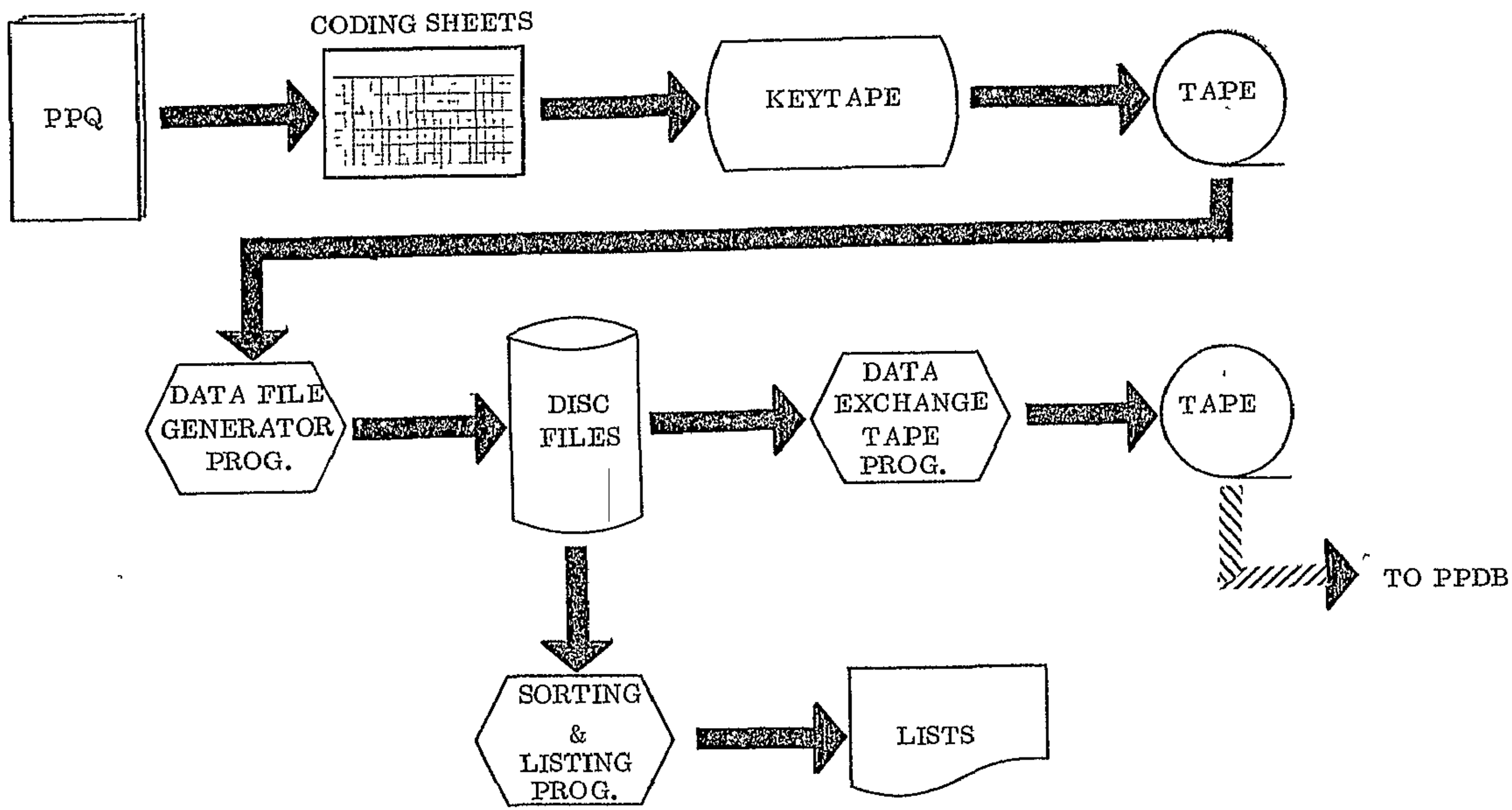
```
          C-08 INSTRUMENT ORIENTATION/TARGETS.
               A.IS POINTING REQUIRED-
C08 01 01        ( ) NO
C08 01 02        ( ) YES.TARGETS ARE
C08 01 02A         ( ) SUN
C08 01 02B         ( ) CELESTIAL TARGETS
C08 01 02C         ( ) EARTHS LIMB
C08 01 02D         ( ) GEOMAGNETIC FIELD LINES
C08 01 02E         ( ) ORBITAL OBJECT TARGETS
C08 01 02F         ( ) NADIR
C08 01 02G         ( ) SPECIFIC EARTH TARGETS
C08 01 02H         ( ) SWATH ACROSS EARTH
C08 01 02I         ( ) OTHER
C08 01 02J         (NOTE CODE)*
               B.GENERAL NOTES
C08 02 01        (NOTE CODE)*
```

- CODING SHEET ENTRIES TRACK QUESTIONNAIRE ITEMS
- CODING SHEETS PROVIDE AN ADDRESS AND A RESPONSE BOX ( ) OR AN ADDRESS AND AN ALPHANUMERIC FIELD * FOR EACH QUESTIONNAIRE ITEM.

```
          C-11 INSTRUMENT MASS.
               A.INSTRUMENT MASS (KG) IS
C11 01 01        ( ) LT 30
C11 01 02        ( ) 30 TO 100
C11 01 03        ( ) GT 100 TO 300
C11 01 04        ( ) GT 300 TO 1000
C11 01 05        ( ) GT 1000 TO 3000
C11 01 06        ( ) GT 3000
               B.ESTIMATED MASS IS
C11 02 01        (KG)*
C11 02 02        (LB)*
               C.GENERAL NOTES
C11 03 01        (NOTE CODE)*
```

- NOTE CODE NUMBERS ARE ASSIGNED AN ADDRESS FOR RECALL.
- ALPHANUMERIC NOTE TEXT IS ENTERED ON A SEPARATE NOTE PAGE, CROSS REFERENCED BY NOTE CODE AND ADDRESS

DATA INPUT TO P/L PLANNING DATA BANK



QUESTIONNAIRE FIELD TEST - EVALUATION CRITERIA

- OPEN ENDED QUESTIONS
  - TYPE/HANDWRITTEN
  - FREQUENCY & LENGTH OF RESPONSE
  - CONTENT ANALYSIS

- NOTES SECTION
  - NUMBER OF NOTES
  - RELATED QUERY
  - CONTENT ANALYSIS

- SUPPLEMENTARY INFORMATION
  - TYPE/HANDWRITTEN
  - FREQUENCY & LENGTH OF RESPONSE
  - CONTENT ANALYSIS

- MARGINAL COMMENTS
  - NUMBER
  - RELATED QUERY
  - CONTENT ANALYSIS

- QUERY ANALYSIS
  - NUMBER UNANSWERED
  - ADDED CHOICES
  - NEGATIVE/POSITIVE BIAS
  - NUMBER OF "MAYBES"

- FOLLOW-UP TELEPHONE CONVERSATION
  - GENERAL IMPRESSION
  - ORGANIZATION
  - CONTENT OF QUESTIONNAIRE
  - TIME TO COMPLETE
  - PERCEIVED VALUE

ORI

FIELD TEST SUMMARY OF RESULTS*

- LIMITED SAMPLE
  - — LIMITED TO INSTRUMENT/EXPERIMENTS BOOKLET
  - — EIGHT RESPONDENTS (13 DISTRIBUTED)
  - — POSSIBLE BIAS TOWARD TECHNOLOGY/APPLICATIONS
- WELL RECEIVED BY P.I.S
  - — POSITIVE ATTITUDE TO NASA INFORMATION NEEDS
  - — SEVERAL SEE USE AS PLANNING AID
  - — NO ADDITIONS/SUBTRACTIONS SUGGESTED
  - — SEVERAL RETAINED COPY FOR FUTURE USE
- RAPIDLY AND ACCURATELY COMPLETED
  - — TWO HOUR AVERAGE
  - — FEW ERASURES OR QUALIFYING STATEMENTS
  - — VERY FEW QUESTIONS LEFT UNANSWERED

*SEE APPENDIX C

RECOMMENDATIONS

- "TO BE USED FOR PLANNING PURPOSES ONLY"*
- ACTUAL RESPONDENT SHOULD BE IDENTIFIED*
- "NASA HEADQUARTERS RESPONSIBLE INDIVIDUAL" DELETED*
- EPM QUESTION MISLEADING*
- CONTAMINATION SENSITIVITY/GENERATION NOT NEEDED — JUST LIST TYPES & LET RESPONDENT SELECT
- RADIATION QUESTION TOO DETAILED
- QUESTIONS ON EVA, RMS & HIGH QUALITY OPTICAL WINDOW SHOULD BE COMBINED "OTHER SPECIAL OPTIONS" AVAILABLE

* ADOPTED IN FINALIZED FORMATS

ORIGINAL

CONTAMINATION SENSITIVITY

Experiments can be influenced by environments produced by the Orbiter or other experiments.

Please review the list below and check (✓) those factors which would adversely affect your instrument or experiment.

a. Particulate Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

b. Gaseous Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

c. Radioactivity:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

d. Electromagnetic Fields (RF):
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

e. Magnetic Fields:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

f. ( ) Other - Explain below.

g. If sensitivity to contamination has been identified above, please list the type(s) and threshold level(s), if possible:________________________
____

RECOMMENDED

CONTAMINATION SENSITIVITY

Please select the types of contamination which would adversely affect your experiment.

a. Particulate ( )

b. Gaseous ( )

c. Radioactivity ( )

d. Electromagnetic(RF) ( )

e. Magnetic Fields ( )

f. Other ________________

4. SUMMARY AND RECOMMENDATIONS

SUMMARY OF RESULTS

TWO BOOKLETS DEVELOPED

- INSTRUMENTS/EXPERIMENTS - INTERFACE WITH A P/L CARRIER
- SHUTTLE PAYLOAD ELEMENTS - INTERFACE WITH STS

"HUMAN ENGINEERED" FORMAT EMPLOYED

- PROGRAMMED INSTRUCTION PRINCIPLES
- STS CAPABILITIES DESCRIPTIONS
- MULTIPLE CHOICE RESPONSES
- BRANCHING
- SELF-CONTAINED
- SINGLE PASS THROUGH

LIMITED LEVEL OF DETAIL

- IDENTIFY POTENTIAL PAYLOADS
- SUPPORT LIMITED COMPATIBILITY ANALYSIS
- PROVIDE REPOSITORY FOR ADDITIONAL DETAILS, IF AVAILABLE

SMALL DATA PACKAGE VOLUME

- BOOKLET 1 - 25 PAGES
- BOOKLET 2 - 30 PAGES

QUESTIONNAIRE UTILIZATION

PAYLOADS IN CONCEPTUAL PHASE

- INFORMS RESPONDENTS OF STS CAPABILITIES
- FURNISHES EASY-TO-ANSWER QUESTIONS
  - RECOGNIZE UNCERTAINTIES
  - OPPORTUNITY FOR UPDATING
- DOESN'T DEMAND DETAILS THAT CAN'T BE ANSWERED YET

PAYLOADS IN DEVELOPMENT PHASE

- PROVIDES SPACE TO ENTER DATA DEVELOPED IN ANALYSIS AND EQUIPMENT DESIGN
- PROVIDES ENOUGH DETAIL FOR LIMITED COMPATIBILITY ANALYSIS

MORE DETAILED INFORMATION IS REQUIRED FOR PAYLOAD MISSION ASSIGNMENT

- BEYOND THE SCOPE OF THIS QUESTIONNAIRE
- OBTAIN FROM ERD (EXPT. REQMT. DOC.), CONTRACT REPORTS, OTHER DOCUMENTS, AND PERSONAL CONTACTS

NEXT LEVEL OF DETAIL

- ELECTRICAL POWER
  - AC VS DC
  - STANDBY
  - PEAKS
  - POWER PROFILE
- FLIGHT ENVIRONMENT
  - TEMPERATURE
  - HUMIDITY
  - ACOUSTIC
  - VIBRATION
  - LAUNCH ACCELERATION
- HAZARDS
  - HIGH PRESSURE
  - CRYOGENICS
  - TOXIC MATERIALS
  - CORROSIVES
  - PYROTECHNICS
- CREW SUPPORT
  - CREW SIZE
  - SKILL MIX
  - TRAINING

PLANNING STEPS

P/L PLANNING QUESTIONNAIRE FOR INITIAL CONTACT - INFORMAL

- INEXPERIENCED STS USERS
- CANDIDATE PAYLOADS IN EARLY DEFINITION PHASES
  - INTRODUCES THEM TO NASA P/L PLANNING PROCEDURES
- ENTER INFORMATION IN DATA BANK

"ACQUISITION OF INVESTIGATIONS" PROCESS - FORMAL

- FREE-FLYERS - AO'S FOR MISSIONS
- SPACELAB - AO'S FOR DISCIPLINES
  - DEVELOP AN INSTRUMENT/EXPERIMENT "POOL"
  - BY EACH PAYLOAD PROGRAM OFFICE
- UPDATE AND EXPAND DATA BANK

RECOMMENDATIONS

- UTILIZE PRESENT QUESTIONNAIRE FORMAT FOR NEXT P/L DATA COLLECTION CYCLE
  - ESTABLISH CONTACT WITH NEW STS USERS
  - OBTAIN PLANNING DATA ON NEW POTENTIAL PAYLOADS
  - INPUT INFORMATION TO P/L DATA BANK
- UPDATE QUESTIONNAIRE CONTENTS & FORMAT
  - UPDATE AND/OR CHANGE STS CAPABILITIES AS NECESSARY, E.G., TELEOPERATOR
  - CLARIFY ITEMS THAT WERE NOT EASILY UNDERSTOOD BY RESPONDENTS
  - INTEGRATE WITH OTHER NASA PAYLOAD DATA COLLECTION ACTIVITIES
  - DIVERSIFY TO ADDITIONAL BOOKLETS
- REPUBLISH/REISSUE QUESTIONNAIRE
  - COLLECT DATA ON NEW PAYLOADS
  - UPDATE/REFINE DATA ON PAYLOADS INCLUDED IN PREVIOUS DATA COLLECTION CYCLE

RECOMMENDED BOOKLET EXPANSION

- SPACELAB INSTRUMENTS/EXPERIMENTS
- INSTRUMENTS/EXPERIMENTS FOR FREE-FLYERS
- SHUTTLE-ATTACHED PAYLOAD ELEMENTS
- FREE-FLYING PAYLOADS
- SPACELAB EXPERIMENT FACILITIES
  - ATMOSPHERIC CLOUD PHYSICS LAB
  - 1m IR TELESCOPE
  - 1m UV TELESCOPE
  - DROP DYNAMICS FACILITY
  - MATERIALS PROCESSING FACILITIES
  - ZERO GRAVITY COMBUSTION FACILITY
  - OTHERS, AS DEVELOPED

APPENDIX A

SPACE TRANSPORTATION SYSTEM

PAYLOAD PLANNING QUESTIONNAIRE

BOOKLET 1 – INSTRUMENTS/EXPERIMENTS

TO BE USED FOR
PLANNING PURPOSES ONLY

National Aeronautics and Space Administration
Washington, D. C 20546

NOTE: Items flagged with asterisk will be completed by NASA Headquarters.

*Code No. __________

Date ______________

1. Payload Title: ____

   ____

2. *Discipline: ____

3. Investigator:

   a. Name - ____

   b. Organization - ____

   c. Mail Address - ____
      Street or P.O. Box

      ____
      City

      ______________________________ ______________
      State Zip

   d. Phone - ____________ ____________________ ____________
      Area Phone No. Ext.

4. NASA Headquarters Responsible Individual:

   a. *Name - ____

   b. *Program Office - ____

   c. *Mail Code - ____________________

   d. *Phone - ____________ ____________________ ____________
      Area Phone No. Ext.

5. Status: ____

   ____

   ____

   ____

   ____

   ____

   ____

PPQ-1-02

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CONTENTS

A. INTRODUCTION

This questionnaire booklet requests a limited quantity of general planning information on *instruments* and *experiments* which will be integrated into the Spacelab and/or free-flying satellites and carried to orbit by the Space Shuttle.

If your instrument or experiment is planned to fly as a *Shuttle* payload element (i.e., not carried by the Spacelab or a free-flying satellite), do not proceed further in this booklet. Instead, utilize Booklet 2 - "Shuttle Payload Elements" which is formatted to accommodate information on Shuttle-attached payloads and free-flying satellites.

The information requested by this questionnaire is not of a detailed nature. The format, organization and contents have been designed to minimize the time required to answer the questions, and to recognize the engineering and scheduling uncertainties inherent in long-range planning.

For the majority of questions your response can be given by simply checking the applicable answer. However, where more detailed information is available, space has been provided to enter such data.

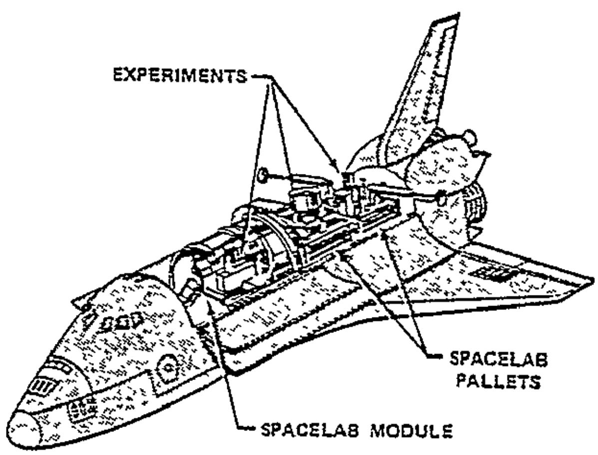
The answers given to these questions will be used for STS payload planning purposes only. Responding to this questionnaire does not imply that funding approval, flight assignment, etc., will automatically follow. The regular NASA "Acquisition of Investigations" process will be employed for the formal solicitation for instruments and experiments.

Recognizing that requirements, such as electrical power, will change as experiments reach maturity, you will be asked periodically to review and update the information reported on the following pages.

The key to routine space operations is the Space Shuttle System. The Space Shuttle's Orbiter vehicle can accommodate a wide spectrum of payloads in its large cargo bay.

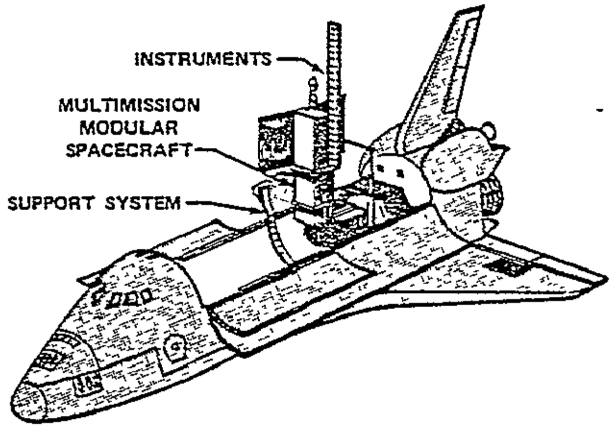
For instance, Spacelabs will be carried aloft by the Shuttle in support of manned orbital operations; free-flying satellites will be deployed in, and recovered from, low earth orbits; and free-flying satellites with propulsive stages will be deployed from the Shuttle and launched into high energy trajectories.

The Spacelab is an international project undertaken by the European Space Agency. Its hardware components are a pressurized laboratory module (with a shirtsleeve working environment) and open equipment pallets (exposed to the space vacuum).

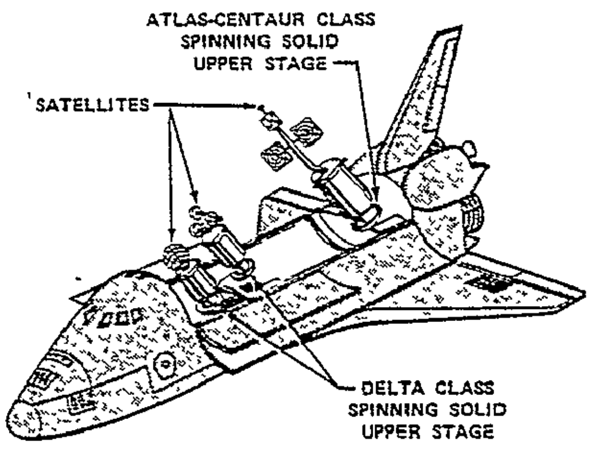


Depending on experiment requirements, the Spacelab hardware can be arranged as a module only, module with pallets, or pallets only. The Spacelab remains attached to the Orbiter throughout a flight.

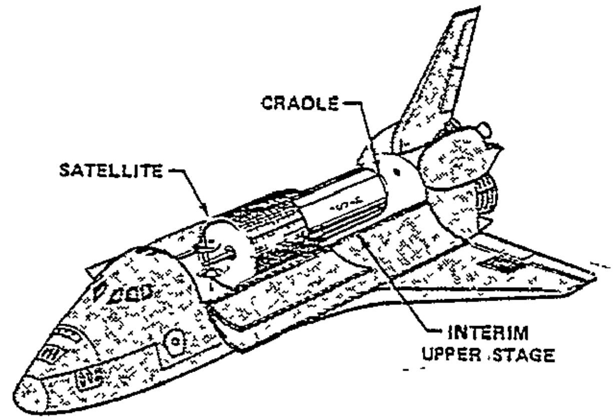
Free-flying satellites that operate in low earth orbit can be checked out and deployed from the cargo bay, serviced and maintained on-orbit, and recovered for return to ground for repair or refurbishment.



Several kinds of upper stages will be used to deliver satellites beyond the Orbiter's earth orbit. Geosynchronous satellites of the Delta or Atlas-Centaur weight and volume class can use the Spinning Solid Upper Stage (SSUS).



Larger satellites headed for geosynchronous, elliptic, and higher circular orbits or destined for deep space can use the large, solid Interim Upper Stage (IUS).



If responding to the questions using the spaces provided does not convey all of the information needed for an adequate understanding of your instrument or experiment requirements, you are requested to add additional explanation in the "Notes" space provided on each page or in Section E, "Supplementary Information".

If your instrument or experiment has any "drop-dead" accommodation or mission requirements that cannot be compromised, or specific target locations, viewing constraints, environmental limits, etc., also explain these requirements in Section E.

Typewritten responses to this questionnaire are not desired; legible handwritten responses will be totally satisfactory. Responses in the International (SI) System of Units are preferred; however, you may use English units instead if you desire.

It is fully understood that many instruments or experiments are in the conceptual phase and that the data which will eventually result from engineering analyses are not available at this time. In this situation, you are requested to respond to the question with your *best estimate*.

B. EXPERIMENT OBJECTIVES AND DESCRIPTION

Using the samples as guides, please provide a brief explanation of the experiment or investigation objectives, and a summary of experiment characteristics.

Experiment Objectives: ______________________________

Sample experiment objective: "To collect high resolution multispectral data for earth resources detection, location, identification, mapping and delineation of land use themes."

Experiment Description: ______________________________

Sample experiment description: "This instrument is a pallet mounted high resolution (10-15m) multispectral (7-band) scanner. It will be accompanied on the pallet by a specialized data processing unit, whose output will be stored on a wideband tape recorder with reel change capability. The units will utilize Spacelab displays, controls and computer support."

Supplementary information such as photographs, sketches and block diagrams can be most helpful to payload planners. If available, please provide applicable information of this type as attachments to Section E, "Supplementary Information," page E-1.

Experiment Categories:
This questionnaire is applicable to two general categories of instruments and experiments: (1) those that require integration with the Spacelab for subsystems and operational support (e.g., structural attachment, power, data handling, pointing, manual manipulation or operation, etc.) and; (2) those that require integration into a free-flying satellite.

However, an instrument destined for ultimate use in a free-flying satellite may initially undergo one or more developmental flight tests aboard the Spacelab. Conversely, an instrument already developed for remote sensing of planetary features could be adaptable as a low cost earth resources sensor for an early Spacelab mission.

Please check (✓) the appropriate category for your instrument or experiment.

( ) This instrument or experiment will be flown aboard the Spacelab.

( ) This instrument or experiment will be flown aboard a free-flying satellite.

( ) This instrument or experiment will be flown aboard *both* the Spacelab and a free-flying satellite.

If your instrument or experiment will be flown aboard *both* the Spacelab and a free-flying satellite, please indicate which type of flight will first occur.

( ) Spacelab

( ) Free-flying satellite

( ) Unknown

Experiment Classes:
For payload planning purposes, instruments and experiments may be classified into one of three payload classes: autonomous, semi-autonomous, and facility-dependent. The primary distinction between these classes is the difference in interfacing of the experiment equipment with the payload carrier (e.g., Shuttle, Spacelab, free-flying satellite) and other payload equipment. The characteristics of each of these classes are described below.

Autonomous experiments are functionally self-contained and depend upon the payload carrier primarily for structural mounting. They do not require subsystems support for power, data handling, thermal control, etc. For example, the "Getaway Special" payloads are small, self-contained experiments of the autonomous class.

Semi-autonomous experiments (or experiment facilities) include the necessary equipment to produce and/or control the required experimental conditions, to transmit or receive the desired electromagnetic radiation, and to measure the induced or observed phenomena with appropriate instruments. In addition to structural mounting, they usually require supporting functions from the payload carrier such as pointing, electrical power, or other subsystem support. The majority of Spacelab and free-flying satellite instruments and experiments are of the semi-autonomous class.

Facility-dependent experiments must be conducted in conjunction with experiment facilities such as telescopes, furnaces and test chambers. (Multi-user facilities of this type will be furnished by NASA for use by many different experimenters or investigators, and will be re-flown many times.)

Examples of experiments of this class are: a specialized sensor or detector which is installed in a telescope facility; a material sample and holding or positioning device for use in a space processing furnace facility. In the above examples, the equipment supplied by the experimenter or investigator is not capable of producing and controlling all of the required conditions, but is dependent upon the experiment facility for these functions. Facility-dependent experiments generally do not interface directly with the payload carrier; instead they interface with the experiment facility.

Examples of multi-user facilities presently planned or in development are as follows:

Atmospheric Cloud Physics Lab
1 m IR Telescope
1 m UV Telescope
Drop Dynamics Facility
Materials Processing Furnaces
Biological Separation Facilities
Zero Gravity Combustion Facility

Documents that describe the characteristics and capabilities of the NASA-supplied multi-user facilities can be obtained from NASA Headquarters.

Based upon the above descriptions, please indicate the classification of your instrument or experiment.

( ) Autonomous

( ) Semi-autonomous

( ) Facility-dependent

If your instrument or experiment is a Spacelab payload of the *autonomous* or *semi-autonomous* class, please turn to Section C, "Flight Requirements - Spacelab Instruments/Experiments", page C-1.

If your instrument or experiment is a free-flying satellite payload of the *autonomous* or *semi-autonomous* class, please turn to Section D, "Flight Requirements - Free-flying Satellite Instruments", page D-1.

If your instrument or experiment is planned to fly aboard <u>both</u> the Spacelab and a free-flying Satellite, please complete the questions in both Sections C and D.

If your instrument or experiment is of the *facility-dependent* class, do not complete Sections C or D. Instead, proceed to Section E, "Supplementary Information", and provide information that will enable payload planners to determine which of the available or planned multi-user facilities could be employed to support your experiment or investigation.

C. FLIGHT REQUIREMENTS - SPACELAB INSTRUMENTS/EXPERIMENTS

This section asks general questions dealing with experiment accommodation requirements (e.g., power, data handling, etc.) and mission characteristics (e.g., on-orbit duration) needed to meet the objectives of your Spacelab-supported experiment or investigation.

CREW TIME

The Orbiter can support a crew of three to seven persons. Three will perform Orbiter operations; one to four Payload Specialists will conduct experiments. Each Payload Specialist can devote about 8 to 10 hours per day to conducting experiments.

Remembering that crew time may be needed for activation, monitoring, equipment stowage, and results analysis, please check (✓) the estimated crew hours per flight required by your experiment.

( ) None
( ) Less than 5 hours
( ) 5 to 10 hours
( ) > 10 to 30 hours
( ) > 30 to 100 hours
( ) More than 100 hours - Explain in "Notes"

EXPERIMENT CONTROL

Experiment operations can be controlled on-board, or by digital commands issued from the ground. While on-board control can be continuous, ground control will be disrupted for periods of up to 10 minutes every 25 to 40 minutes because of communications blockages.

NOTES:

Please check (✓) as applicable.

( ) Experiment does not require any control.
( ) Experiment requires only "on/off" commands.
( ) Experiment requires real-time active control (closed-loop).

If real-time active control *is* required, there are several methods by which it can be accomplished.

Please check (✓) the applicable method(s).

( ) By on-board crew
( ) By on-board computer
( ) By digital command from ground.

MISSION DURATION

On a standard Spacelab flight the Orbiter will remain aloft for 7 days. This duration can be extended to 30 days if the necessary provisions are added.

Please check (✓) the mission duration required to achieve the desired objectives of your experiment.

( )< 4 days ( ) 4 to 7 days
( ) 8 to 15 days ( ) 16 to 30 days
( )>30 days - Explain in "Notes"

Please check (✓) the mission duration required to achieve the *minimum* objectives of your experiment.

( )< 4 days ( ) 4 to 7 days
( ) 8 to 15 days ( ) 16 to 30 days
( )>30 days - Explain in "Notes"

EXTRAVEHICULAR ACTIVITIES (EVA)

The Orbiter provides the systems and personnel needed to perform manual tasks outside the pressurized work area. Nominal resources permit two, two-man EVA's, each lasting six hours per flight.

EVA can be used for operation of equipment; deployment, positioning, retraction of booms; cargo transfer; etc. Planned use of EVA must carefully consider and trade-off the potential reduction in experiment equipment complexity versus the additional crew time required for EVA preparation, task execution, and stowage of equipment.

Please check (✓) one.

( ) EVA is *not* needed for the normal operation of this experiment.

( ) EVA *is* needed for the normal operation of this experiment.

( ) EVA *may* be needed for normal operation of this equipment.

DATA MANAGEMENT

Two-way communication links that carry data and voice between the Shuttle and ground stations will be maintained for 55-70% of the orbital mission. An onboard recorder can be used to store data for delayed transmission to the ground.

Down Link:

Digital Data (≤50M bps)
Analog & TV (≤4.2M Hz)
Voice

NOTES:

Up Link:

Digital & Command (≤2k bps)
Voice

Spacelab data management services include a general purpose computer, a high-rate (≤32M bps) digital tape recorder (26 data tracks), and display/keyboard unit(s). The Orbiter's payload recorder can record digital (≤1 M bps) or analog (≤2 MHz) data on each of 14 tracks.

Are the standard data management capabilities sufficient for your experiment?

Yes ( ); Maybe ( ); No ( ) - Explain in "Notes"

Estimate data management requirements, if possible:

Down Link:

Digital: No ( ); Maybe ( ); Yes ( ).
Digital Rate:_______________bps
Analog: No ( ); Maybe ( ); Yes ( ).
Analog Bandwidth:____________Hz
Television: No( ); Maybe( );Yes( ).
Voice: No ( ); Maybe ( ); Yes ( ).

Up Link:

Digital: No ( ); Maybe ( ); Yes ( ).
Digital Rate:_______________bps
Voice: No ( ); Maybe ( ); Yes ( ).

On-board

General Purpose Computer:
No ( );Maybe ( ); Yes ( ).

Display/Keyboard Unit:
No ( ); Maybe ( ); Yes ( ).

Other - Explain in "Notes"

COMMUNICATION COVERAGE

Communications contacts between the Shuttle and ground control stations (via the Tracking and Data Relay Satellite System) are dictated by orbit parameters and vehicle attitude. Real-time communications will be possible for 55-70% of the time.

Some experiments may need real-time communication on a *random schedule*. That is, the events that bring on communications are unpredictable.

Some experiments may need real-time communication on a *fixed schedule;* that is, at fixed times into the mission or at fixed (or known) orbital positions.

Some experiments may need real-time communication on a *flexible - schedule*. That is, convenient times for communications can be chosen before or during the mission.

For normal operation of this experiment, *real-time* communication with the ground:

( ) is *not* needed.
( ) is or may be needed on a *flexible schedule*.
( ) is or may be needed on a *fixed schedule*.
( ) is or may be needed on a *random schedule*.
( ) Other - Explain in "Notes"

NOTES:

REMOTE MANIPULATOR ARMS

The Orbiter provides one 15.24m (50 ft) long remote manipulator arm to perform experiment operations outside the pressurized work area.

The arm includes a mechanical hand to grasp and move equipment components. In the manual operating mode, the hand can be positioned linearly to an accuracy of ± 3.8 cm (± 1.5 in), and rotationally to within 0.5 deg. In the automatic mode, these positioning accuracies are, respectively, ± 5.1 cm (± 2.0 in) and 5.0 deg.

With the arm fully extended, the maximum force exerted at the tip is 6.8 kg (15 lb). At other arm positions relative to the attach point, this force can grow to 23 kg (50 lb).

There are also a light and a TV camera for remote payload viewing. A second arm can be added for experiments requiring servicing with two arms.

Please check (✓) as appropriate.

( ) Remote manipulator arms will *not* be needed for normal experiment operations.

For normal experiment operations:

( ) one arm *may* be needed.
( ) one arm *will* be needed.
( ) two arms *may* be needed.
( ) two arms *will* be needed.

INSTRUMENT ORIENTATION/TARGETS

The Orbiter can point at any desired inertial, local vertical, earth fixed, or orbital object target.

Does your experiment require instrument pointing?

( ) No; ( ) Yes.

If not, skip to page C-6.

If pointing *is* required, please check (✓) the target(s) for your experiment.

( ) Sun
( ) Celestial targets
( ) Earth's limb
( ) Geomagnetic field lines
( ) Orbital object targets
( ) Nadir
( ) Specific earth targets
( ) Swath across earth
( ) Other - Explain in "Notes"

Depending upon pointing accuracy and stability requirements, instrument pointing may be accomplished using the basic Orbiter attitude control system (ACS) capabilities or by using an Experiment Pointing Mount (EPM).

ORBITER POINTING AND STABILIZATION

Using the ACS vernier thrusters, instruments mounted to the Spacelab pallet, scientific airlock or high quality window can be pointed with an accuracy on the order of $\pm$ 2 degrees, with a stability (deadband) of $\pm$ 0.1 deg per axis. The stability rate (maximum limit cycle rate) is $\pm$ 0.01 deg/sec per axis.

NOTES:

Are the basic Orbiter pointing and stabilization capabilities satisfactory for your experiment?

( ) Yes; ( ) Maybe; ( ) No.

If you answered "Yes", skip to page C-6.

If not, the basic Orbiter pointing capability can be improved if the instrument complement provides an attitude reference signal to the Orbiter. A pointing accuracy on the order of $\pm$ 0.5 degree can be achieved.

Is this improved pointing capability satisfactory for your experiment?

( ) Yes; ( ) Maybe; ( ) No.

If you answered "Yes", skip to page C-6.

EXPERIMENT POINTING MOUNTS

If experiment pointing and stabilization requirements exceed Orbiter capabilities, the instrument must be installed on an Experiment Pointing Mount (EPM). Several types of NASA-provided mounts will be available, or the experiment itself may include a pointing and stabilization capability.

Please complete the following statement.

Pointing will be provided by:

( ) the experiment.
( ) a NASA-provided EPM.
( ) unknown.

The two primary factors that influence the choice of an Experiment Pointing Mount are instrument *mass* and the *stability* required.

INSTRUMENT MASS

Please check (✓) the mass range for the instrument to be mounted on an EPM.

( ) <30 kg
( ) 30 to 100 kg (220 lb)
( ) >100 to 300 kg (660 lb)
( ) >300 to 1000 kg (2205 lb)
( ) >1000 to 3000 kg (6615 lb)
( ) >3000 kg

Or, estimate mass, if possible:

__________kg, or ___________lb

POINTING STABILITY

Please check (✓) the pointing stability range required by your instrument (expressed as maximum allowable error).

( ) ≥360 arc sec
( ) <360 to 20 arc sec
( ) <20 to 1 arc sec
( ) <1 to 0.1 arc sec
( ) <0.1 arc sec

Or, estimate stability requirement, if possible:

____________________arc sec

EPM POINTING ACCURACY

If absolute pointing accuracy greater than ± 2 degrees is required, an additional attitude reference sensing method must be employed to reduce bias errors due to IMU drift, structural misalignment, thermal distortion, etc.

Depending upon the magnitude of pointing accuracy required, a package of optical sensors (e.g., star trackers, solar sensors, horizon sensors) can be mounted to the instrument structure, or the instrument may incorporate devices used to derive its own attitude reference signals. In either case, the attitude reference data is introduced to the computer that controls the EPM.

Please check (✓) the pointing accuracy range required by your instrument (expressed as maximum allowable error).

( ) Unknown
( ) ≥2 degrees
( ) <2 to 1/2 degree
( ) <1/2 to 1/10 degree
( ) <360 to 60 arc sec
( ) <60 to 10 arc sec
( ) <10 to 1 arc sec
( ) <1 arc sec

Or, estimate pointing accuracy requirement, if possible:___________arc sec

Please list any other important pointing accuracy and stability requirements below:

____

____

____

____

____

____

NOTES:

CONTAMINATION SENSITIVITY

Experiments can be influenced by environments produced by the Orbiter or other experiments.

Please review the list below and check (✓) those factors which would adversely affect your instrument or experiment.

a. Particulate Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

b. Gaseous Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

c. Radioactivity:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

d. Electromagnetic Fields (RF):
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

e. Magnetic Fields:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

f. ( ) Other - Explain in "Notes".

g. If sensitivity to contamination has been identified above, please list the type(s) and threshold level(s) in the "Notes".

CONTAMINATION GENERATION

Experiments can produce conditions which might influence other experiments.

Please review the list below and check (✓) those conditions which might be produced by your experiment.

a. Particulate Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

b. Gaseous Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

c. Radioactivity
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

d. Electromagnetic Fields (RF)
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

e. Magnetic Fields
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

f. ( ) Other - Explain in "Notes".

g. If generation of contamination has been identified above, please list the type(s) and magnitude(s) in the "Notes".

NOTES:

DESIRED ORBIT PARAMETERS

Shuttle/Spacelab missions will typically be flown at altitudes ranging between 250 km (135 n.mi) to 470 km(254 n.mi.), and at inclinations ranging from 28½ to 90 degrees.

Please indicate below the orbit parameters (altitude and inclination) or range of parameters compatible with your experiment.

( ) Any orbit is acceptable.

( ) Desired orbit parameters are:

Inclination -

from:__________deg

to:__________deg

Altitude -

from:__________km,

or________n.mi.

to:__________km,

or________n.mi.

( ) Unknown.

The next several questions contain information concerning viewing opportunities and environmental factors that are related to orbit parameters. This information will provide mission planners with a better understanding of your instrument or experiment requirements.

RADIATION

Exposure of personnel and equipment to trapped and cosmic radiation depends on Orbiter/Spacelab altitude and position with respect to the earth's geomagnetic poles and the South Atlantic Anomaly.

NOTES:

Polar orbits increase exposure to cosmic radiation (e.g., protons, alpha particles, and heavier nuclei) whereas orbits taking the spacecraft through the South Atlantic Anomaly increase exposure to trapped radiation (e.g., electrons, protons).

With respect to your experiment:

( ) Any radiation dose rate within health limits is acceptable.

( ) Radiation dose rates should be minimized.

( ) Exposure to high dose rates is desirable - Explain in "Notes". Include desired dose rates and class(es) of radiation, if known.

Estimate radiation limits for your instrument or experiment, if possible:

Operating

Electrons -

Flux________; Energy________

Protons -

Flux________; Energy________

Other____________________

____

Non-operating

Electrons -

Flux________; Energy________

Protons -

Flux________; Energy________

Other____________________

____

ACCELERATION LEVEL

Depending on orbit altitude, background acceleration levels caused by atmospheric drag will vary between approximately 10^{-6} to 10^{-8}g.

Please check (✓) the maximum allowable background acceleration level for your experiment. (The corresponding altitude is also indicated.)

( ) 3×10^{-6}g @ 250km (135 n.mi.)
( ) 1×10^{-6}g @ 300km (162 n.mi.)
( ) 5×10^{-7}g @ 350km (189 n.mi.)
( ) 1×10^{-7}g @ 425km (230 n.mi.)
( ) 5×10^{-8}g @ 470km (254 n.mi.)
( ) Any of the above
( ) Other - Explain in "Notes"

Orbiter attitude maneuvering, crew activity and subsystems operations will induce acceleration transients in the range of 10^{-2} to 10^{-4}g. These transients can be avoided for finite time periods by allowing the Orbiter to "drift" (i.e., no attitude maneuvering) and by controlling crew activity and subsystems operations (i.e., timelining to avoid conflicting operations).

Please check (✓) the maximum allowable acceleration transient level for your experiment.

( ) 10^{-2}g ( ) 10^{-3}
( ) 10^{-4}g ( ) $<10^{-4}$g
( ) Any of the above.
( ) Other - Explain in "Notes".

If your experiment requires a specific controlled gravity level (i.e., artificial "g") or range of levels, please explain in "Notes".

AMBIENT PRESSURE

As orbital altitude increases, the atmospheric pressure surrounding the Orbiter and within the cargo bay will, of course, decrease.

Does your experiment employ pallet-mounted equipment or other equipment that requires access to the space environment?

( ) No; ( ) Yes.

If not, skip to page C-9.

If access to the space environment is required, please check (✓) the maximum atmospheric pressure allowable. (The approximate corresponding altitude is also given.)

	Pressure	Altitude
( )	5×10^{-5} N/m^2	@ 250 km
	(3.8×10^{-7}Torr)	(135 n.mi.)
( )	2.5×10^{-5}N/m^2	@ 287 km
	(1.9×10^{-7}Torr)	(155 n.mi.)
( )	1×10^{-5}N/m^2	@ 342 km
	(7.6×10^{-8}Torr)	(185 n.mi.)
( )	5×10^{-6} N/m^2	@ 390 km
	(3.8×10^{-8} Torr)	(210 n.mi.)
( )	2.5×10^{-6} N/m^2	@ 440 km
	(1.9×10^{-8}Torr)	(238 n.mi.)
( )	1×10^{-6} N/m^2	@ 512 km
	(7.6×10^{-9} Torr)	(276 n.mi.)

( ) Any of the above

( ) Other - Explain in "Notes")

NOTES:

EARTH OBSERVATIONS

Does your experiment require viewing of phenomena or targets on the earth's surface or within the atmosphere?

( ) No; ( ) Yes.

If not, skip to page C-10.

If your experiment *requires* earth observations, please check (√) the latitudes in which you wish to make observations.

( ) 0 to 28.5 deg.
( ) 0 to 57 deg.
( ) 0 to 90 deg.
( ) Any latitude is acceptable
( ) Not yet determined.

Please use the "Notes" to describe more precisely the latitude(s) your experiment requires, if known. If a target list is available, please attach it to Section E.

The time that an earth target is observable depends on Orbiter altitude and the position of the target with respect to the orbit ground trace. Typically, the maximum time that an earth target is in the line-of-sight of the Orbiter is about 5 to 7 minutes of one orbit.

What is the minimum amount of time in one orbit that your instrument must be in the line-of-sight of the target to collect data?

( ) <1 min. ( ) 1 to 2 min.
( ) >2 to 4 min ( ) >4 to 7 min.
( ) Not yet determined.
( ) Other - Explain in "Notes".

NOTES:

If more precise observational times are known, please explain in Section E.

If known, please list your target viewing repetition rate and the number of observations required.

Repetition rate: ____________________

____

____

____

No. of observations: ____________________

____

____

____

If known, please list your ground target illumination requirements.

Sun elevation angle: ____________________

____

____

____

Other: ____________________

____

____

____

DAY/NIGHT CYCLE

Depending on altitude and inclination, the Orbiter/Spacelab can be exposed to various day/night cycles ranging from continuous exposure to the sun to solar exposure for some 50 minutes of each 90 minute orbit of the earth.

Is the day/night cycle of any consideration in the conduct of your experiment?

( ) No; ( ) Yes.

If not, skip to the next question.

If solar exposure *is* a factor in performing your experiment or observation, please check (✓) your requirement.

- ( ) Continuous exposure (100%)
- ( ) Maximum exposure (75 to 100%)
- ( ) Minimum exposure (55 to 75%)
- ( ) A specific day/night cycle or range of cycles is desirable - Please explain in "Notes".

FLIGHT SCHEDULING

Some experiments may require a launch schedule timed to expose the experiment to specific events, environments, or phenomena.

Please check (✓) the launch scheduling factors which must be considered for your experiment.

- ( ) Seasons of the year
- ( ) Ground target illumination
- ( ) Solar activity
- ( ) Phase of the moon or planets
- ( ) Celestial target viewing
- ( ) Other - Explain in "Notes"
- ( ) None known

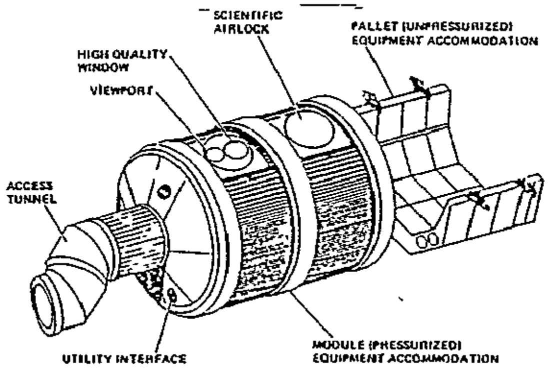
NOTES:

EXPERIMENT ACCOMMODATIONS

Experiment equipment may be carried aloft either in a *pressurized* volume (i.e., the Spacelab module or the Orbiter cabin) or in the *unpressurized* volume of the Orbiter's payload bay, mounted to a Spacelab pallet or to a special structure.

Some experiments will use equipment in both the pressurized and unpressurized volumes, e.g., an instrument mounted on a pallet, supported by controls mounted in a module.

The Spacelab module provides a shirtsleeve environment and supplies experiment services (power, cooling and data management). Support equipment such as standard racks, an airlock and a high quality optical window can be provided if required.



The Spacelab pallet (an unpressurized platform to which equipment may be mounted) also provides experiment services. Pallets can be flown with or without the Spacelab module.

In pallet-only configuration, experiments can be controlled from the Orbiter's aft flight deck or from the ground.

EQUIPMENT WEIGHT & VOLUME (PRESSURIZED AREA)

Experiment equipment operated in the pressurized work area can be mounted in the Spacelab module, or in the Orbiter's aft flight deck.

Equipment in the module will be mounted in 19 inch racks, in double-width (38 inch) racks, or to the module floor. Each rack has connectors for power, cooling, and data management services.

Each single 19-inch rack can carry up to $0.9m^3$ (32 ft^3) of equipment. Please check (✓) the total volume and weight ranges of your equipment in the Spacelab module (not including Spacelab-supplied support equipment).

Volume

- ( ) None
- ( ) Experiment can share a single rack as follows:
  - ( ) Up to 1/4 rack
  - ( ) >1/4 to 1/2 rack
  - ( ) >1/2 to 3/4 rack
- ( ) One complete single rack
- ( ) Experiment requires more than one single rack as follows:
  - ( ) 2 single racks (not necessarily adjoining)
  - ( ) 1 double rack
  - ( ) Other - Explain in "Notes".

NOTES:

Weight

- ( ) None
- ( ) <30 kg (66 lb)
- ( ) 30 to 75 kg (165 lb)
- ( ) >75 to 150 kg (330 lb)
- ( ) >150 to 300 kg (660 lb)
- ( ) >300 to 600 kg (1320 lb)
- ( ) >600 kg - Explain in "Notes"

Or, estimate weight, if possible:

__________kg, or ____________lb

Experiment support equipment can be mounted in $0.67m^3$ (23.6 ft^3) of volume in the Orbiter's aft flight deck, where limited power, cooling and data management services are provided.

Will your experiment mount equipment in the Orbiter aft flight deck?

Yes ( ); Maybe ( ); No ( )

If you answered "yes" or "maybe", please estimate the volume and weight of these equipment items, if possible:

Volume

__________m^3, or __________ft^3

Weight

__________kg, or __________lb

ELECTRICAL POWER (PRESSURIZED AREA)

Experiments inside the Spacelab module will share continuous electrical power in the range of 2.0 to 2.5 kW. Electrical service will be both DC (28 volt) and AC (115/200 volt, 400 Hz, 3 phase).

Please check (✓) the range of electrical power consumption (total DC and AC) for operating your experiment equipment in the Spacelab module.

( ) None
( ) <100 watts
( ) 100-500 watts
( ) >500-1000 watts
( ) >1000-2500 watts
( ) >2500 watts - Explain in "Notes"

Or, estimate power, if possible:
____________________ watts

Please check (✓) the range of total time your experiment will be consuming power at the rate indicated above.

( ) None
( ) <10 hours
( ) 10-25 hours
( ) >25-80 hours
( ) >80-168 hours
( ) >168-300 hours
( ) >300-600 hours
( ) >600 hours - Explain in "Notes"

Or, estimate time, if possible:_____hours

Equipment in the Orbiter's aft flight deck can share up to 300 watts of electrical power (DC and AC).

Will your experiment require electrical power from the Orbiter's aft flight deck?

Yes ( ); No ( ); Maybe ( ).

NOTES:

SCIENTIFIC AIRLOCK

The Spacelab module can carry a scientific airlock (mounted in the top of the module) capable of extending instruments some 0.96m (3.15 ft) into space and retracting them. Instruments may be up to 1m (3.28 ft) in diameter and 1m (3.28 ft) in length.

Instruments up to 100 kg (220 lb) can be launched/landed in the airlock, and may be loaded into and/or removed from the airlock during the mission. Instruments using the airlock can receive Spacelab-provided experiment services.

The scientific airlock:

( ) is *not* needed by this experiment.
( ) *is* needed by this experiment.
( ) *may* be needed by this experiment.

OPTICAL WINDOW

A high quality optical window that provides viewing access to earth, deep space, and the sun can be installed in the top of the module.

The window is a rectangular pane 41 x 55 cm (16.1 x 21.6 inches) with optical transmission exceeding 65% at all wavelengths between 400-1000 nm. Parallelism is maintained within 2 arc seconds.

The high quality optical window:

( ) is *not* needed by this experiment.
( ) *is* needed by this experiment.
( ) *may* be needed by this experiment.

EQUIPMENT SIZE (UNPRESSURIZED AREA)

For Spacelab missions, equipment items located in the Orbiter cargo bay will generally be mounted to pallets. However, in some cases very large items will be mounted to special support structures.

Each Spacelab pallet is 4.35m (14.35 ft) wide and 2.88m (9.4 ft) long. Pallets can be connected into 2 or 3 pallet trains. Please check (✓) the total pallet area range required by your experiment (1 pallet ≅ $12m^2$ or 130 ft^2).

( ) None

( ) Less than $1m^2$ (11 ft^2)

( ) $1m^2$ to $3m^2$ (33 ft^2)

( ) >$3m^2$ to $6m^2$ (65 ft^2)

( ) >$6m^2$ to $12m^2$ (130 ft^2)

( ) Greater than $12m^2$ - Explain in "Notes".

Or, estimate area, if possible:

__________ m^2, or __________ ft^2

The payload clearance envelope in the Orbiter's cargo bay measures 18.3m (60 ft) in length and 4.6m (15 ft) in diameter. Please (✓) check the length range of your experiment equipment which will be mounted to a special support structure rather than the Spacelab pallet.

( ) None

( ) Less than 2m (6.6 ft)

( ) 2m to 5m (16.4 ft)

( ) >5m to 10m (33 ft)

( ) >10m to 15m (49 ft)

( ) >15m to 18.3m (60 ft)

Or, estimate length, if possible:

__________ m, or __________ ft

And, estimate width, if possible:

__________ m, or __________ ft

If possible, please attach a dimensioned sketch of your experiment equipment in Section E.

If a sketch is not available, please provide a dimensioned envelope drawing in the space provided below.

ENVELOPE DRAWINGS:

(If your experiment employs equipment that deploys or expands to a larger size, please show both the stowed and deployed sizes.)

NOTES:

EQUIPMENT WEIGHT (UNPRESSURIZED AREA)

The total weight for all equipment and provisions needed to conduct experiments (including the Spacelab, experiment equipment and other support equipment) cannot exceed 14,514 kg (32,000 lb) at landing.

One spacelab pallet can carry up to 3000 kg (6,615 lb) of equipment, and a two or three pallet train can carry up to 5000 kg (11,025 lb).

Please check (✓) the total weight range of your experiment equipment which is to be mounted on Spacelab pallets (including consumables, but excluding Spacelab equipment weight).

( ) None
( ) <100 kg (220 lb)
( ) 100-500 kg (1,102 lb)
( ) >500-3000 kg (6,615 lb)
( ) >3000-5000 kg (11,025 lb)
( ) >5000 kg - Explain in "Notes"

Or, estimate weight, if possible:
__________kg, or __________lb

Please check (✓) the total weight range of your experiment equipment which will not utilize a Spacelab pallet but which will be mounted to a special support structure (including the weight of the special support structure and any consumables contained within the experiment equipment).

( ) None
( ) <1000 kg (2,205 lb)
( ) 1000-3000 kg (6,615 lb)
( ) >3000-10,000 kg (22,050 lb)
( ) >10,000-14,514 kg(32,000 lb)
( ) >14,514 kg - Explain in "Notes"

Or, estimate weight, if possible:
__________kg, or __________lb

NOTES:

ELECTRICAL POWER (UNPRESSURIZED AREA)

The Orbiter's electrical network can provide 7kW of DC power to the cargo bay. Spacelab subsystems, when operating, consume from 1.6 to 4.4 kW.

Equipment on the Spacelab pallet will share continuous electrical power in the range of 1.5 to 4.5 kW. Electrical service will be both DC (28 volt) and AC (115/200 volt, 400 Hz, 3 phase).

Please check (✓) the range of electrical power (total DC and AC) to be supplied by the Shuttle/Spacelab electrical distribution networks for operating your experiment equipment in the cargo bay.

( ) None
( ) <100 watts
( ) 100-300 watts
( ) >300-1500 watts
( ) >1500-4500 watts
( ) >4500-7000 watts
( ) >7000 watts - Explain in "Notes"

Or, estimate power, if possible:
________________watts

Please check (✓) the total time range your experiment will be consuming power at the rate indicated above.

( ) None
( ) <10 hours
( ) 10-25 hours
( ) >25-80 hours
( ) >80-168 hours
( ) >168-300 hours
( ) >300-600 hours
( ) >600 hours - Explain in "Notes"

Or, estimate time, if possible:
________________hours

EXPERIMENT AVAILABILITY

Please indicate below the development status of your instrument or experiment.

( ) Development *has not yet begun.*

( ) Development *is underway.*

( ) Development *is complete* and hardware is available now.

If development *has not yet begun,* please check (✓) your best estimate of the time required to design, construct, test and deliver your instrument or experiment, starting from program approval date.

( ) Less than one year.

( ) One to 2 years.

( ) Two to 3 years.

( ) Three to 5 years.

( ) More than 5 years.

If development *is underway,* please enter below the *earliest* date when your instrument or experiment could be delivered for integration into the Spacelab.

Delivery Date:__________ __________
Month Year

NOTES:

EXPERIMENT REFLIGHT

Does this Spacelab experiment utilize any instruments that might be suitable for later use by other experiments on-board free-flying satellites?

Yes ( ); Maybe ( );No ( )

Some Spacelab experiments are designed to be performed completely on one mission (assuming no significant malfunctions). These "one shot" experiments have no need for, nor could they benefit from, reflight on a Spacelab or on a free-flying satellite.

Is this a "one shot" investigation?

Yes ( ); No ( )

If you answered "yes," please turn to Section E, "Supplementary Information", page E-1; otherwise continue with this question.

Other experiments require only one Spacelab mission, and require or might benefit from conduct on a free-flying satellite. These experiments neither require nor could benefit from reflight on a Spacelab mission. Is your investigation of this type?

Yes ( ); No( )

If you answered "yes," please turn to Section D, "Flight Requirements - Free-Flying Satellite Instruments", page D-1; otherwise continue with this question.

Please check (✓) as appropriate:

( ) This investigation *requires* more than one Spacelab flight to meet its objectives.

( ) This investigation, while requiring only one Spacelab flight, *might benefit from* reflight on subsequent Spacelab missions.

Please estimate the desired number of Spacelab reflights (not including the initial flight) of this experiment.

No. of reflights:____________________

For planning purposes, can the answers you have given to the questions on pages C-1 through C-15 be considered as "typical" for all Spacelab reflights of this experiment?

Yes ( ); No ( )

If you answered "no", please list major differences in reflight requirements:____________

____

____

____

If your instrument is a candidate for flight on a free-flying satellite, please complete the questions in Section D, "Flight Requirements - Free-flying Satellite Instruments", page D-1.

If your instrument or experiment is not a candidate for flight on a free-flying satellite, please turn to Section E, "Supplementary Information", page E-1.

D. FLIGHT REQUIREMENTS - - FREE-FLYING SATELLITE INSTRUMENTS

This section asks a few very general questions about your satellite-borne instrument that will identify it to NASA mission planners as a candidate for future flight opportunities.

INSTRUMENT ACCOMMODATIONS

Individual instruments and experiments will require physical and functional integration into a free-flying spacecraft which will provide the necessary supporting services.

The supporting spacecraft may be a standard NASA payload carrier such as the Long Duration Exposure Facility (LDEF) or the Multimission Modular Spacecraft (MMS), or it may be a specialized design that is developed for a particular mission or series of missions.

The Long Duration Exposure Facility (LDEF) is a reusable, unmanned free-flying structure that provides a means for exposing experiments to the space environment. It is placed in earth orbit for 6 months or more, and is then retrieved and returned to earth for analysis of experiment results.

Structural support for the experiments is provided by mounting trays supplied by NASA. No other subsystem support is provided by the LDEF, although experiments may contain their own power and data handling systems.

NOTES:

The Multimission Modular Spacecraft (MMS) can support earth-, solar-, and celestial-oriented instruments in both near-earth and geosynchronous orbits. It provides a standard baseline of sub-systems support that can be adapted to accommodate a wide range of instrument and experiment requirements, thus reducing the cost and lead time required to produce a flight-ready satellite. The MMS can either be brought back from low earth orbit for repair or refurbishment or it can be reserviced on orbit by the Space Shuttle, as desired by the user.

Please indicate below the type(s) of free-flying satellite that is a potential carrier for your instrument or experiment.

( ) LDEF

( ) MMS
- ( ) Low earth orbit
- ( ) Geosynchronous orbit
- ( ) Other - Explain in "Notes"

( ) Interplanetary spacecraft

( ) Other: ____________________
____
____

The information furnished in this questionnaire will be forwarded to the appropriate Program Office. You will be notified of forthcoming flight opportunities that may be appropriate for your instrument.

E. SUPPLEMENTARY INFORMATION

This section is provided for you to add information that is important for a better understanding of your instrument or experiment.

Please check (✓) the type of supplementary information you have attached to this questionnaire.

- ( ) Sketches, drawings, photographs
- ( ) Instrument/experiment data sheets
- ( ) Block diagrams or flow charts
- ( ) Reference documents or reports
- ( ) List of reference documents
- ( ) List/description of mission or accommodation requirements that cannot be compromised
- ( ) Target list for earth or celestial observations
- ( ) Description of observational times for earth observations
- ( ) Other descriptive information is provided on page E-2
- ( ) No supplementary information is furnished at this time.

Page E-2 provides space for any explanatory text you care to add.

Thank you.

Please use the space below, and additional sheets if necessary, to add any information that you feel is important to defining the mission, spacecraft or other accommodations or environments required by your instrument or investigation.

APPENDIX B

PPQ-2-02

SPACE TRANSPORTATION SYSTEM

PAYLOAD PLANNING QUESTIONNAIRE

BOOKLET 2 – SHUTTLE PAYLOAD ELEMENTS

TO BE USED FOR PLANNING PURPOSES ONLY

National Aeronautics and Space Administration
Washington, D. C. 20546

NOTE: Items flagged with asterisk will be completed by NASA Headquarters.

*Code No. ____________

Date ____________

1. Payload Title: ______________________________

____

2. *Discipline: ______________________________

3. Investigator:

   a. Name - ______________________________

   b. Organization - ______________________________

   c. Mail Address - ______________________________
      Street or P.O. Box
      ____
      City
      ______________________ ____________
      State Zip

   d. Phone - ________ ______________ ________
      Area Phone No. Ext.

4. NASA Headquarters Responsible Individual:

   a. *Name - ______________________________

   b. *Program Office - ______________________________

   c. *Mail Code - ____________

   d. *Phone - ________ ______________ ________
      Area Phone No. Ext.

5. Status: ______________________________

____

____

____

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PPQ-2-02

CONTENTS

CONTENTS (Cont'd)

A. INTRODUCTION

This questionnaire booklet requests a limited quantity of general planning information on scientific and commercial payload elements which will be carried to orbit by the Space Shuttle.

If your payload is planned to fly as an instrument or experiment carried by the Spacelab or a free-flying satellite (i.e., does not interface *directly* with the Shuttle), do not proceed further in this booklet. Instead, utilize Booklet I - "Instruments/ Experiments".

The information requested by this questionnaire is not of a detailed nature. The format, organization and contents have been designed to minimize the time required to answer the questions, and to recognize the engineering and scheduling uncertainties inherent in long-range planning.

For the majority of questions your response can be given by simply checking the applicable answer. However, where more detailed information is available, space has been provided to enter such data.

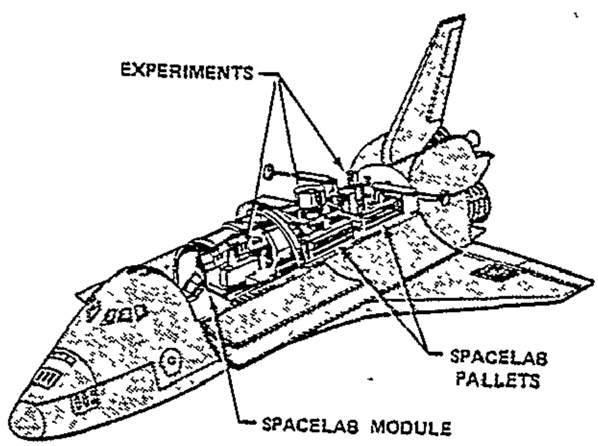
The answers given to these questions will be used for STS payload planning purposes only. Responding to this questionnaire does not imply that funding approval, flight assignment, etc., will automatically follow. The regular NASA "Acquisition of Investigations" process will be employed for the formal solicitation for payloads.

Recognizing that requirements, such as electrical power, will change as payloads reach maturity, you will be asked periodically to review and update the information reported on the following pages.

The key to routine space operations is the Space Shuttle System. The Space Shuttle's Orbiter vehicle can accommodate a wide spectrum of payloads in its large cargo bay.

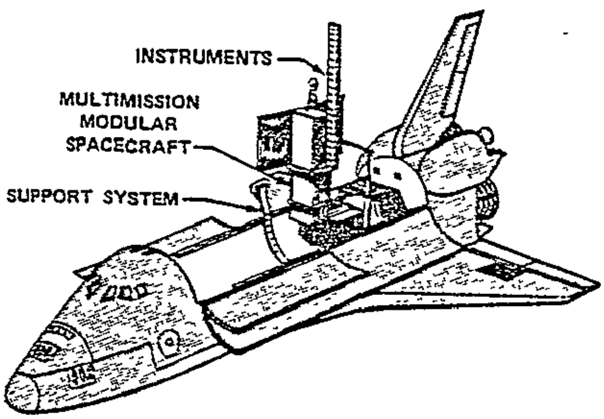
For instance, Spacelabs will be carried aloft by the Shuttle in support of manned orbital operations; free-flying satellites will be deployed in, and recovered from, low earth orbits; and free-flying satellites with propulsive stages will be deployed from the Shuttle and launched into high energy trajectories.

The Spacelab is an international project undertaken by the European Space Agency. Its hardware components are a pressurized laboratory module (with a shirtsleeve working environment) and open equipment pallets (exposed to the space vacuum).

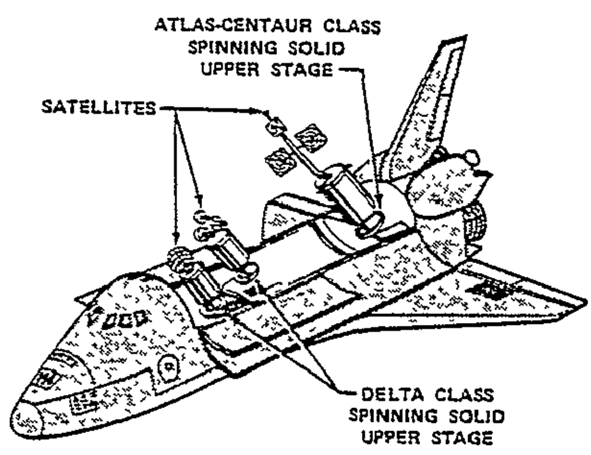


Depending on experiment requirements, the Spacelab hardware can be arranged as a module only, module with pallets, or pallets only. The Spacelab remains attached to the Orbiter throughout a flight.

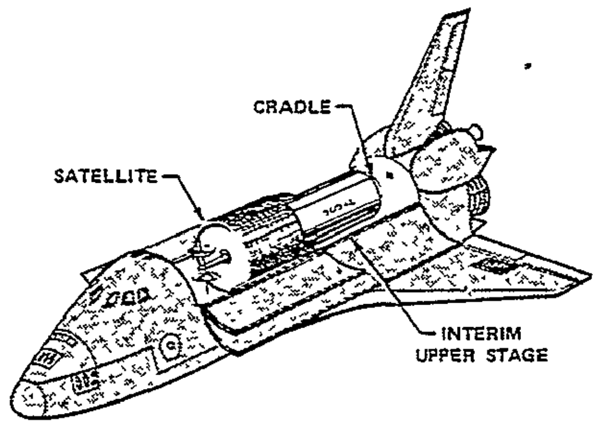
Free-flying satellites that operate in low earth orbit can be checked out and deployed from the cargo bay, serviced and maintained on orbit, and recovered for return to ground for repair or refurbishment.



Several kinds of upper stages will be used to deliver satellites beyond the Orbiter's earth orbit. Geosynchronous satellites of the Delta or Atlas-Centaur weight and volume class can use the Spinning Solid Upper Stage (SSUS).



Larger satellites headed for geosynchronous, elliptic, and higher circular orbits or destined for deep space can use the large, solid Interim Upper Stage (IUS).



If responding to the questions using the spaces provided does not convey all of the information needed for an adequate understanding of your payload requirements, you are requested to add additional explanation in the "Notes" space provided on each page or in Section E, "Supplementary Information".

If your payload element has any "drop-dead" accommodation or mission requirements that cannot be compromised, or specific target locations, viewing constraints, environmental limits, etc., also explain these requirements in Section E.

Typewritten responses to this questionnaire are not desired; legible handwritten responses will be totally satisfactory. Responses in the International (SI) System of Units are preferred; however, you may use English units instead if you desire.

It is fully understood that many payloads are in the conceptual phase and that the data which will eventually result from engineering analyses are not available at this time. In this situation, you are requested to respond to the question with your *best estimate*.

B. PAYLOAD OBJECTIVES AND DESCRIPTION

Using the samples as guides, please provide a brief explanation of the payload objectives, and a summary of payload characteristics.

Payload Objectives: ____

____

____

____

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____

____

Sample payload objective: "To obtain stereo photographs of the earth's surface along the ground track of the satellite to aid the exploration geologist in search of oil reserves."

Payload Description: ____

____

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____

Sample payload description: "The satellite will include two cameras, one pointing downward and 30 degrees up the satellite track, and the other pointing downward and 30 degrees down the satellite track. Each camera operates in the 0.8 to 1.1 micrometer spectral range and photographs 40 km cross track with 20m resolution."

Supplementary information such as photographs, sketches, and block diagrams can be most helpful to payload planners. If available, please provide applicable information of this type as attachments to Section E, "Supplementary Information", page E-1.

Payload Types:

Space Transportation System payloads are of two general types - *attached* and *free-flying*.

Attached payloads *remain with* the Orbiter for relatively short mission durations (up to 30 days). They may be mounted in the Orbiter cargo bay or in the crew cabin. They generally require supporting services from the Orbiter (e.g., electrical power, cooling, and data management) during the orbital phase of the mission.

Free-flying payloads *are released from* the Orbiter and operate independent of the Shuttle for relatively long periods of time (months to years). Satellites that operate at altitudes higher than the Orbiter may have self-contained propulsion systems, or they may use an additional propulsive upper stage.

Please check (✓) the appropriate description of your payload.

( ) This payload is of the attached type and will remain with the Orbiter for the entire flight duration.

( ) This payload is a free-flying system and will be released from the Orbiter in low earth orbit.

( ) This payload remains attached to the Orbiter during initial orbital operations and will then be released as a free-flying system.

If your payload is of the *attached* type, please turn to Section C, "Flight Requirements - Attached Payloads", page C-1.

If your payload is a *free-flying* system, please turn to Section D, "Flight Requirements - Free-flying Payloads", page D-1.

If your payload has characteristics of *both* types, please complete the questions in both Sections C and D.

C. FLIGHT REQUIREMENTS - ATTACHED PAYLOADS

This section asks general questions dealing with payload accommodation requirements (e.g., power, data handling, etc.) and mission characteristics (e.g., on-orbit duration) needed to meet the objectives of your Shuttle-attached payload element.

CREW TIME

The Orbiter can support a crew of three to seven persons. Three will perform Orbiter operations; one to four Payload Specialists will conduct payload operations. Each Payload Specialist can devote about 8 to 10 hours per day to conducting payload operations.

Remembering that crew time may be needed for activation, monitoring, equipment stowage, and results analysis, please check (✓) the estimated crew hours per flight required by your payload.

- ( ) None
- ( ) Less than 5 hours
- ( ) 5 to 10 hours
- ( ) >10 to 30 hours
- ( ) >30 to 100 hours
- ( ) More than 100 hours - Explain in "Notes"

PAYLOAD CONTROL

Payload operations can be controlled on-board, or by digital commands issued from the ground. While on-board control can be continuous, ground control will be disrupted for periods of up to 10 minutes every 25 to 40 minutes because of communications blockages.

NOTES:

Please check (✓) as applicable.

- ( ) Payload does not require any control.
- ( ) Payload requires only "on/off" commands.
- ( ) Payload requires real-time active control (closed-loop).

If real-time active control *is* required, there are several methods by which it can be accomplished.

Please check (✓) the applicable method(s).

- ( ) By on-board crew
- ( ) By on-board computer
- ( ) By digital command from ground.

MISSION DURATION

On a standard flight with an attached payload the Orbiter will remain aloft for 7 days. This duration can be extended to 30 days if the necessary provisions are added.

Please check (✓) the mission duration required to achieve the *desired* objectives of your payload.

( ) <4 days ( ) 4 to 7 days
( ) 8 to 15 days ( ) 16 to 30 days
( ) >30 days - Explain in "Notes"

Please check (✓) the mission duration required to achieve the *minimum* objectives of your payload.

( ) <4 days ( ) 4 to 7 days
( ) 8 to 15 days ( ) 16 to 30 days
( ) >30 days - Explain in "Notes"

EXTRAVEHICULAR ACTIVITIES (EVA)

The Orbiter provides the systems and personnel needed to perform manual tasks outside the pressurized work area. Nominal resources permit two, two-man EVA's, each lasting six hours per flight.

EVA can be used for operation of equipment; deployment, positioning, retraction of booms; cargo transfer; etc. Planned use of EVA must carefully consider and trade-off the potential reduction in experiment equipment complexity versus the additional crew time required for EVA preparation, task execution, and stowage of equipment.

Please check (✓) one.

- ( ) EVA is *not* needed for the normal operation of this payload.
- ( ) EVA *is* needed for the normal operation of this payload.
- ( ) EVA *may* be needed for normal operation of this payload.

DATA MANAGEMENT

Two-way communication links that carry data and voice between the Shuttle and ground stations will be maintained for 55-70% of the orbital mission. An onboard recorder can be used to store data for delayed transmission to the ground.

Down Link:

- Digital Data (≤50M bps)
- Analog & TV (≤4.2M Hz)
- Voice

NOTES:

Up Link:

- Digital & Command (≤2k bps)
- Voice

Payloads attached to the Orbiter can use the Orbiter's general purpose computer, 14-track analog (≤2M Hz)/digital (≤1M bps) data recorder, and display/keyboard unit for data management.

Are the Orbiter's standard data management capabilities sufficient for your payload?

Yes ( ); Maybe ( ); No ( ) - Explain in "Notes"

Estimate data management requirements, if possible:

Down Link:

- Digital: No ( ); Maybe ( ); Yes ( ).
- Digital Rate:____________bps
- Analog: No ( ); Maybe ( ); Yes ( ).
- Analog Bandwidth:____________Hz
- Television: No( ); Maybe( ); Yes( ).
- Voice: No ( ); Maybe ( ); Yes ( ).

Up Link:

- Digital: No ( ); Maybe ( ); Yes ( ).
- Digital Rate:____________bps
- Voice: No ( ); Maybe ( ); Yes ( ).

On-board

- General Purpose Computer:
  No ( ); Maybe ( ); Yes ( ).
- Display/Keyboard Unit:
  No ( ); Maybe ( ); Yes ( ).

Other - Explain in "Notes"

COMMUNICATION COVERAGE

Communications contacts between the Shuttle and ground control stations (via the Tracking and Data Relay Satellite System) are dictated by orbit parameters and vehicle attitude. Real-time communications will be possible for 55-70% of the time.

Some payloads may need real-time communication on a *random schedule*. That is, the events that bring on communications are unpredictable.

Some payloads may need real-time communication on a *fixed schedule*; that is, at fixed times into the mission or at fixed (or known) orbital positions.

Some payloads may need real-time communication on a *flexible schedule*. That is, convenient times for communications can be chosen before or during the mission.

For normal operation of this payload, *real-time* communication with the ground:

( ) is *not* needed.
( ) is or may be needed on a *flexible schedule*.
( ) is or may be needed on a *fixed schedule*.
( ) is or may be needed on a *random schedule*.
( ) Other - Explain in "Notes"

NOTES:

REMOTE MANIPULATOR ARMS

The Orbiter provides one 15.24m (50 ft) long remote manipulator arm to perform payload operations outside the pressurized work area.

The arm includes a mechanical hand to grasp and move equipment components. In the manual operating mode, the hand can be positioned linearly to an accuracy of ± 3.8 cm (± 1.5 in), and rotationally to within 0.5 deg. In the automatic mode, these positioning accuracies are, respectively, ± 5.1 cm (± 2.0 in) and 5.0 deg.

With the arm fully extended, the maximum force exerted at the tip is 6.8 kg (15 lb). At other arm positions relative to the attach point, this force can grow to 23 kg (50 lb).

There are also a light and a TV camera for remote payload viewing. A second arm can be added for payloads requiring servicing with two arms.

Please check (✓) as appropriate.

( ) Remote manipulator arms will *not* be needed for normal payload operations.

For normal payload operations:

( ) one arm *may* be needed.
( ) one arm *will* be needed.
( ) two arms *may* be needed.
( ) two arms *will* be needed.

PAYLOAD ORIENTATION/TARGETS

The Orbiter can point at any desired inertial, local vertical, earth fixed, or orbital object target.

Does your payload require controlled orientation or pointing?

( ) No; ( ) Yes.

If *not*, skip to page C-6.

If pointing *is* required, please check (✓) the target(s) for your payload.

( ) Sun
( ) Celestial targets
( ) Earth's limb
( ) Geomagnetic field lines
( ) Orbital object targets
( ) Nadir
( ) Specific earth targets
( ) Swath across earth
( ) Other - Explain in "Notes"

Depending upon pointing accuracy and stability requirements, payload pointing may be accomplished using the basic Orbiter attitude control system (ACS) capabilities or by using an Experiment Pointing Mount (EPM).

ORBITER POINTING AND STABILIZATION

Using the ACS vernier thrusters, payloads mounted to the Orbiter can be pointed with an accuracy on the order of ± 2 degrees, with a stability (deadband) of ± 0.1 deg per axis. The stability rate (maximum limit cycle rate) is ± 0.01 deg/sec per axis.

NOTES:

Are the basic Orbiter pointing and stabilization capabilities satisfactory for your experiment?

( ) Yes; ( ) Maybe; ( ) No.

If you answered "Yes," skip to page C-6.

If not, the basic Orbiter pointing capability can be improved if the payload provides an attitude reference signal to the Orbiter. A pointing accuracy on the order of ± 0.5 degree can be achieved.

Is this improved pointing capability satisfactory for your payload?

( ) Yes; ( ) Maybe; ( ) No.

If you answered "Yes," skip to page C-6.

EXPERIMENT POINTING MOUNTS

If payload pointing and stabilization requirements exceed Orbiter capabilities, the instrument must be installed on an Experiment Pointing Mount (EPM). Several types of NASA-provided mounts will be available, or the payload itself may include a pointing and stabilization capability.

Please complete the following statement.

Pointing will be provided by:

( ) The payload
( ) A NASA-provided EPM
( ) Unknown.

The two primary factors that influence the choice of an Experiment Pointing Mount are instrument *mass* and the *stability* required.

INSTRUMENT MASS

Please check (✓) the mass range for the instrument to be mounted on an EPM.

( ) <30 kg
( ) 30 to 100 kg (220 lb)
( ) >100 to 300 kg (660 lb)
( ) >300 to 1000 kg (2205 lb)
( ) >1000 to 3000 kg (6615 lb)
( ) >3000 kg

Or, estimate mass, if possible:
__________kg, or __________lb

POINTING STABILITY

Please check (✓) the pointing stability range required by your instrument (expressed as maximum allowable error).

( ) ≥360 arc sec
( ) <360 to 20 arc sec
( ) <20 to 1 arc sec
( ) <1 to 0.1 arc sec
( ) <0.1 arc sec

Or, estimate stability requirement, if possible:
__________________arc sec

EPM POINTING ACCURACY

If absolute pointing accuracy greater than ±2 degrees is required, an additional attitude reference sensing method must be employed to eliminate bias errors due to IMU drift, structural misalignment, thermal distortion, etc.

Depending upon the magnitude of pointing accuracy required, a package of optical sensors (e.g., star trackers, solar sensors, horizon sensors) can be mounted to the instrument structure, or the instrument may incorporate devices used to derive its own attitude reference signals. In either case, the attitude reference data is introduced to the computer that controls the EPM.

Please check (✓) the pointing accuracy range required by your instrument (expressed as maximum allowable error).

( ) Unknown
( ) ≥2 degrees
( ) <2 to 1/2 degree
( ) <1/2 to 1/10 degree
( ) <360 to 60 arc sec
( ) <60 to 10 arc sec
( ) <10 to 1 arc sec
( ) <1 arc sec

Or, estimate pointing accuracy requirement, if possible:__________arc sec

Please list any other important pointing accuracy and stability requirements below:

____
____
____
____

NOTES:

CONTAMINATION SENSITIVITY

Payload elements can be influenced by environments produced by the Orbiter or other payloads.

Please review the list below and check (✓) those factors which would adversely affect your payload element.

a. Particulate Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

b. Gaseous Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

c. Radioactivity:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

d. Electromagnetic Fields (RF):
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

e. Magnetic Fields:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

f. ( ) Other - Explain in "Notes."

g. If sensitivity to contamination has been identified above, please list the type(s) and threshold level(s) in the "Notes."

CONTAMINATION GENERATION

Payload elements can produce conditions which might influence other payloads.

Please review the list below and check (✓) those conditions which might be produced by your payload element.

a. Particulate Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

b. Gaseous Contamination:
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

c. Radioacitivity
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

d. Electromagnetic Fields (RF)
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

e. Magnetic Fields
   While operating -
      No ( ); Maybe ( ); Yes ( )
   While non-operating -
      No ( ); Maybe ( ); Yes ( )

f. ( ) Other - Explain in "Notes".

g. If generation of contamination has been identified above, please list the type(s) and magnitude(s), in the "Notes".

NOTES:

DESIRED ORBIT PARAMETERS

Shuttle missions with attached payloads will typically be flown at altitudes ranging between 250 km (135 n.mi) to 470 km(254 n.mi.), and at inclinations ranging from 28½ to 90 degrees.

If possible, indicate below the orbit parameters (altitude and inclination) or range of parameters compatible with your payload.

( ) Any orbit is acceptable.
( ) Desired orbit parameters are:
Inclination -
from:__________deg
to:__________deg
Altitude -
from:__________km,
or__________n.mi.
to:__________km,
or__________n.mi.
( ) Unknown.

The next several questions contain information concerning viewing opportunities and environmental factors that are related to orbit parameters. This information will provide mission planners with a better understanding of your payload requirements.

RADIATION

Exposure of personnel and equipment to trapped and cosmic radiation depends on Orbiter altitude and position with respect to the earth's geomagnetic poles and the South Atlantic Anomaly.

NOTES:

Polar orbits increase exposure to cosmic radiation (e.g., protons, alpha particles, and heavier nuclei) whereas orbits taking the spacecraft through the South Atlantic Anomaly increase exposure to trapped radiation (e.g., electrons, protons).

With respect to your payload element:

( ) Any radiation dose rate within health limits is acceptable.
( ) Radiation dose rates should be minimized.
( ) Exposure to high dose rates is desirable - Explain in "Notes". Include desired dose rates and class(es) of radiation, if known.

Estimate radiation limits for your payload, if possible:

Operating
Electrons -
Flux__________; Energy__________
Protons -
Flux__________; Energy__________
Other ____________________

Non-operating
Electrons -
Flux__________; Energy__________
Protons -
Flux__________; Energy__________
Other ____________________

ACCELERATION LEVEL

Depending on orbit altitude, background acceleration levels caused by atmospheric drag will vary between approximately 10^{-6} to 10^{-8}g.

Please check (✓) the maximum allowable background acceleration level for your payload. (The approximate corresponding altitude is also indicated.)

- ( ) 3×10^{-6}g @ 250km (135 n.mi.)
- ( ) 1×10^{-6}g @ 300km (162 n.mi.)
- ( ) 5×10^{-7}g @ 350km (189 n.mi.)
- ( ) 1×10^{-7}g @ 425km (230 n.mi.)
- ( ) 5×10^{-8}g @ 470km (254 n.mi.)
- ( ) Any of the above
- ( ) Other - Explain in "Notes"

Orbiter attitude maneuvering, crew activity and subsystems operations will induce acceleration transients in the range of 10^{-2} to 10^{-4}g. These transients can be avoided for finite time periods by allowing the Orbiter to "drift" (i.e., no attitude maneuvering) and by controlling crew activity and subsystems operations (i.e., timelining to avoid conflicting operations).

Please check (✓) the maximum allowable acceleration transient level for your payload.

- ( ) 10^{-2}g   ( ) 10^{-3}
- ( ) 10^{-4}g   ( ) $<10^{-4}$g
- ( ) Any of the above.
- ( ) Other - Explain in "Notes".

If your payload requires a specific controlled-gravity level (i.e., artificial "g") or range of levels, please explain in "Notes".

NOTES:

AMBIENT PRESSURE

As orbital altitude increases, the atmospheric pressure surrounding the Orbiter and within the cargo bay will, of course, decrease.

Does your payload require access to the space environment?

( ) No; ( ) Yes.

If not, skip to page C-9.

If access to the space environment *is* required, please check (✓) the maximum atmospheric pressure allowable. (The approximate corresponding altitude is also given.)

	Pressure	Altitude
( )	5×10^{-5}N/m^2 (3.8 x 10^{-7}Torr)	@ 250 km (135 n.mi.)
( )	2.5×10^{-5}N/m^2 (1.9 x 10^{-7}Torr)	@ 287 km (155 n.mi.)
( )	1×10^{-5}N/m^2 (7.6 x 10^{-8}Torr)	@ 342 km (185 n.mi.)
( )	5×10^{-6}N/m^2 (3.8 x 10^{-8}Torr)	@ 390 km (210 n.mi.)
( )	2.5×10^{-6}N/m^2 (1.9 x 10^{-8}Torr)	@ 440 km (238 n.mi.)
( )	1×10^{-6}N/m^2 (7.6 x 10^{-9}Torr)	@ 512 km (276 n.mi.)

( ) Any of the above

( ) Other - Explain in "Notes")

EARTH OBSERVATIONS

Does your payload require viewing of phenomena or targets on the earth's surface or within the atmosphere?

( ) Yes; ( ) No.

If *not*, skip to page C-10.

If your payload *requires* earth observations, please check (✓) the latitudes in which you wish to make observations.

( ) 0 to 28.5 deg.
( ) 0 to 57 deg.
( ) 0 to 90 deg.
( ) Any latitude is acceptable
( ) Not yet determined.

Please use the "Notes" to describe more precisely the latitude(s) your payload requires, if known. If a target list is available, please attach it to Section E.

The time that an earth target is observable depends on Orbiter altitude and the position of the target with respect to the orbit ground trace. Typically, the maximum time that an earth target is in the line-of-sight of the Orbiter is about 5 to 7 minutes of one orbit.

What is the minimum amount of time in one orbit that your payload must be in the line-of-sight of the target to collect data?

( ) <1 min. ( ) 1 to 2 min.
( ) >2 to 4 min. ( ) >4 to 7 min.
( ) Not yet determined.
( ) Other - Explain in "Notes".

NOTES:

If more precise observational times are known, please explain in Section E.

If known, please list your target viewing repetition rate and the number of observations required.

Repetition rate: ____________________

____

____

____

No. of observations: ____________________

____

____

____

If known, please list your ground target illumination requirements.

Sun elevation angle: ____________________

____

____

____

Other: ____________________

____

____

DAY/NIGHT CYCLE

Depending on altitude and inclination, the Orbiter can be exposed to various day/night cycles ranging from continuous exposure to the sun to solar exposure for some 50 minutes of each 90 minute orbit of the earth.

Is the day/night cycle of any consideration in the conduct of your payload operations?
( ) No; ( ) Yes.

If *not*, skip to the next question.

If solar exposure *is* a factor in conducting your payload operations, please check (✓) your requirement.

- ( ) Continuous exposure (100%)
- ( ) Maximum exposure (75 to 100%)
- ( ) Minimum exposure (55 to 75%)
- ( ) A specific day/night cycle or range of cycles is desirable - Please explain in "Notes".

FLIGHT SCHEDULING

Some payloads may require a launch schedule timed to expose the payload to specific events, environments, or phenomena.

Please check (✓) the launch scheduling factors which must be considered for your payload.

- ( ) Seasons of the year
- ( ) Ground target-illumination
- ( ) Solar activity
- ( ) Phase of the moon or planets
- ( ) Celestial target viewing
- ( ) Other - Explain in "Notes"
- ( ) None known

NOTES:

PAYLOAD ACCOMMODATIONS

Payload equipment may be carried aloft either in the pressurized Orbiter cabin or in the unpressurized volume of the Orbiter's cargo bay.

The choice of location will depend on factors such as size, the need for manned access, and whether the equipment requires direct exposure to space.

The Orbiter supplies basic services such as power, cooling and data management. Payloads can be controlled from the Orbiter's aft flight deck or from the ground.

EQUIPMENT WEIGHT & VOLUME (PRESSURIZED AREA)

Payload equipment operated in the pressurized work area can be mounted in $0.67 m^3$ ($23.6 ft^3$) of volume in the Orbiter's aft flight deck, where limited power, cooling and data management services are provided.

Will your payload mount equipment in the Orbiter aft flight deck?
No ( ); Maybe ( ); Yes ( ).

If you answered "yes" or "maybe", please estimate the volume and weight of these equipment items, if possible:

Volume

________ m^3, or ________ ft^3

Weight

________ kg, or ________ lb

ELECTRICAL POWER (PRESSURIZED AREA)

Payload equipment in the Orbiter's aft flight deck will share up to 750 watts of continuous electrical power (AC and DC).

Will your payload require electrical power from the Orbiter's aft flight deck?

No ( ); Maybe ( ); Yes ( ).

If you answered "yes" or "maybe", please check (✓) the range of electrical power consumption (total DC and AC) for operating your payload equipment in the aft flight deck.

( ) <50 watts
( ) 50 to 100 watts
( ) >100 to 300 watts
( ) >300 to 500 watts
( ) >500 to 750 watts
( ) >750 watts - Explain in "Notes"

Or, estimate power, if possible:

____________________watts

Please check (✓) the range of total time your payload will be consuming power at the rate indicated above.

( ) <10 hours
( ) 10-25 hours
( ) >25-80 hours
( ) >80-168 hours
( ) >168-300 hours
( ) >300-600 hours
( ) >600 hours - Explain in "Notes"

Or, estimate time, if possible:

____________________hours

NOTES:

ELECTRICAL POWER (UNPRESSURIZED AREA)

Payload elements mounted in the Orbiter's cargo bay will share continuous electrical power up to 7.0 kW. Electrical service will be 28 volt DC.

Please check (✓) the range of electrical power consumption for operating your payload equipment in the cargo bay.

( ) None
( ) <100 watts
( ) 100-300 watts
( ) >300-1500 watts
( ) >1500-4500 watts
( ) >4500-7000 watts
( ) >7000 watts - Explain in "Notes"

Or, estimate power, if possible:

____________________watts

Please check (✓) the range of total time your payload will be consuming power at the rate indicated above.

( ) None
( ) <10 hours
( ) 10-25 hours
( ) >25-80 hours
( ) >80-168 hours
( ) >168-300 hours
( ) >300-600 hours
( ) >600 hours - Explain in "Notes"

Or, estimate time, if possible:

____________________hours

PAYLOAD ELEMENT WEIGHT (UNPRESSURIZED AREA)

The total weight for all equipment and provisions needed to conduct payload operations cannot exceed 14,514 kg (32,000 lb) at landing.

Please check (✓) the weight range of your payload equipment which is to be mounted in the Orbiter's cargo bay.

( ) None
( ) <1000 kg (2,205 lb)
( ) 1000-3000 kg (6,615 lb)
( ) >3000-10,000 kg (22,050 lb)
( ) >10,000-14,514 kg(32,000 lb)
( ) >14,514 kg - Explain in "Notes"

Or, estimate weight, if possible:
__________kg, or ________________lb

PAYLOAD SIZE (UNPRESSURIZED AREA)

Payload elements can be mounted directly to standardized attachment fittings along the sides and bottom of the Orbiter's cargo bay.

The payload clearance envelope in the Orbiter's cargo bay measures 18.3m (60 ft) in length and 4.6m (15 ft) in diameter. Please (✓) check the length range of your payload equipment which will be mounted in the cargo bay.

( ) None
( ) Less than 2m (6.6 ft)
( ) >2m to 5m (16.4 ft)
( ) >5m to 10m (33 ft)
( ) >10m to 15m (49 ft)
( ) >15m to 18.3m (60 ft)

Or, estimate length, if possible:
_____________m, or __________ft

And, estimate width, if possible:
_____________m, or __________ft

If possible, please attach a dimensioned sketch of your payload equipment in Section E.

If a sketch is not available, please provide a dimensioned envelope drawing in the space provided below.

ENVELOPE DRAWINGS:

(If your payload employs equipment that deploys or expands to a larger size, please show both the stowed and deployed sizes.)

NOTES:

PAYLOAD AVAILABILITY

Please indicate below the development status of your payload element.

( ) Development *has not yet begun.*

( ) Development *is underway.*

( ) Development *is complete* and hardware is available now.

If development *has not yet begun,* please check (✓) your best estimate of the time required to design, construct, test and deliver your payload element, starting from program approval date.

( ) Less than one year.

( ) One to 2 years.

( ) Two to 3 years.

( ) Three to 5 years.

( ) More than 5 years.

If development *is underway,* please enter below the *earliest* date when your payload element could be delivered for integration into the Shuttle.

Delivery Date: ______________ ______________
Month Year

NOTES:

PAYLOAD REFLIGHT

Does this payload element utilize any instruments that might be suitable for later use on-board free-flying satellites?

Yes ( ); Maybe ( );No ( )

Some Shuttle-attached payloads are designed to complete their operations on one mission (assuming no significant malfunctions). These "one shot" investigations have no need for, nor could they benefit from, reflight on the Shuttle or on a free-flying satellite.

Is this a "one shot" investigation?

Yes ( ); No ( )

If you answered "yes," please turn to Section E, "Supplementary Information", page E-1; otherwise continue with this question.

Other investigations require only one Shuttle-attached mission, and require or might benefit from conduct on a free-flying satellite. These payloads neither require nor could benefit from reflight on a Shuttle- attached mission. Is your investigation of this type?

Yes ( ); No( )

If you answered "yes," please turn to Section D, "Flight Requirements - Free-Flying Payloads", page D-1; otherwise continue with this question.

Please check (✓) as appropriate:

( ) This investigation *requires* more than one Shuttle flight to meet its objectives.

( ) This investigation, while requiring only one Shuttle flight, *might benefit from* reflight on subsequent Shuttle missions.

Please estimate the desired number of Shuttle reflights (not including the initial flight) of this Shuttle-attached payload.

No. of reflights:________________

For planning purposes, can the answers you have given to the questions on C-1 through C-13 be considered as "typical" for all reflights of this Shuttle-attached payload?

Yes ( ); No ( )

If you answered "no", please list major differences in reflight requirements: ______

____

____

____

If your payload also has a free-flying operational phase, please complete the questions in Section D, "Flight Requirements - Free-flying Payloads", page D-1.

If your payload does not have a free-flying operational phase, please turn to Section E, "Supplementary Information", page E-1.

D. FLIGHT REQUIREMENTS - FREE-FLYING PAYLOADS

This section asks general questions dealing with free-flying payload accommodation requirements (e.g., power, data handling, crew time, etc.) and mission characteristics (e.g., on-orbit duration) needed to meet the objectives of your earth-orbiting-satellite or interplanetary spacecraft.

Free-flying satellites and spacecraft will be carried aloft and if retrieved, returned to earth in the Orbiter's cargo bay, which is about 4.6m (15 ft) in diameter and 18.3m (60 ft) long.

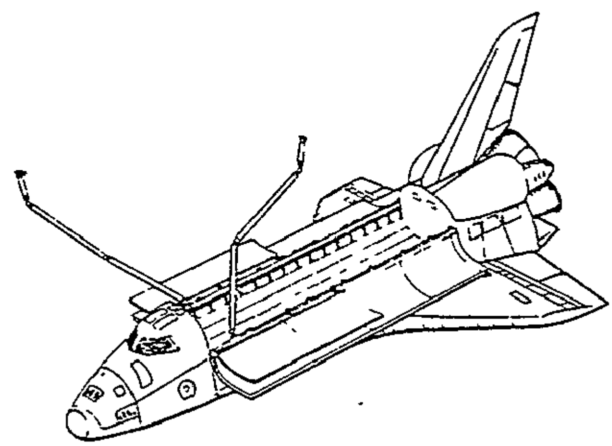
Payloads can be placed directly into earth orbits ranging in inclination from 28.5 degrees (low inclination) to 104 degrees (sun-synchronous), at altitudes from 185 km (100 n.mi.) to about 550 km (300 n.mi.).

The Shuttle's propulsion capability can be increased (at the expense of allowable payload weight and volume) to achieve higher altitudes. However, weight trade-offs strongly suggest that free-flying payloads with operational altitudes above 460 km (250 n.mi.) should plan to provide self-contained propulsion systems or use one of the STS-provided upper stages to launch the payload from a 296 km (160 n.mi.) parking orbit into the operational orbit.

NOTES:

For a nominal altitude of 296 km (160 n.mi.), the total cargo weight that can be delivered by the Shuttle (no additional propulsion capability) is a function of launch inclination.

Inclination	Weight	
Degrees	kg	(lb)
28.5	29,484	(65,000)
56	28,855	(57,000)
90	16,783	(37,000)
104	13,608	(30,000)



In addition to systems for payload deployment and retrieval, the Orbiter provides the capability for on-board data management, pre- and post-release communications with the payload, Orbiter-ground communications, and extravehicular activity (EVA) for payload servicing.

NUMBER OF PAYLOADS

Some missions will require that two or more satellite or spacecraft payloads be deployed by the Shuttle for simultaneous or cooperative operation (Multi-payload Missions).

Other missions will require that only one payload be deployed to operate independently for the duration of its operational life (Single-payload Missions).

Please check (✓) one:

( ) This is a Single-payload Mission

( ) This is or might be a Multi-payload Mission

If this is a Single-payload Mission, please continue to the next item in the questionnaire.

If it is a Multi-payload Mission, please contact the person who signed the letter of transmittal with this questionnaire and secure sufficient copies of the questionnaire to complete *one* for *each* of the payloads in the mission.

DESIRED ORBIT PARAMETERS

If you already know the orbit parameters (altitude and inclination) compatible with your payload, please give them below. (If a *non-circular* earth orbit is desired, please give the *apogee* and *perigee* in the "Notes".)

NOTES:

Desired orbit parameters are:

Inclination -

from: __________deg

to: ____________deg

Altitude -

from: ________km,

or ________n.mi.

to: __________km,

or ________n.mi.

Escape trajectory to:________________

____

If orbit parameters are *not* now known, please provide your best estimate by selecting the most appropriate of the ranges listed below.

ORBITAL INCLINATION

Please indicate below the desired operational inclination for your payload.

( ) Inclination is *unconstrained*
( ) 0 degrees (equatorial)
( ) >0 to 15 degrees
( ) >15. to 28.5 degrees
( ) >28.5 to 45 degrees
( ) >45 to 57 degrees
( ) >57 to 70 degrees
( ) >70 to 90 degrees
( ) >90 to 104 degrees
( ) Escape trajectory
( ) Other - Explain in "Notes"

OPERATIONAL ALTITUDE

Please indicate below the desired operational altitude of your payload (if non-circular, estimate *apogee* and *perigee* in the "Notes").

( ) Altitude is *unconstrained*
( ) <325 km (175 n.mi.)
( ) 325 km to 460 km (250 n.mi.)
( ) >460 km to 600 km (325 n.mi.)
( ) >600 km to 830 km (450 n.mi.)
( ) >830 km to 1060 km (575 n.mi.)
( ) >1060 km to near geosynchronous
( ) Geosynchronous
( ) Escape trajectory
( ) Other - Explain in "Notes"

HIGH ALTITUDE SATELLITES

Satellites launched from Shuttle orbits into high altitude or geosynchronous orbits can use self-contained propulsion systems or an STS-provided upper stage.

The Spinning Solid Upper Stage (SSUS) can inject either of two weight classes of satellites into geosynchronous transfer orbits. These satellites *must* provide their own propulsion systems for final insertion from the transfer orbit into the desired geosynchronous orbit.

The "Delta class" (SSUS-D) can inject about 1088 kg (2,400 lb) into a geosynchronous transfer orbit, with a spin-stabilization capability of up to 100 rpm.

Will your satellite use a SSUS-D?

Yes ( ); No ( ); Maybe ( )

The "Atlas Centaur class" (SSUS-A) can inject about 1990 kg (4,400 lb) into a geosynchronous transfer orbit, with a spin capability of up to 65 rpm.

NOTES:

Will your satellite use a SSUS-A?

Yes ( ); No ( ); Maybe ( )

The Interim Upper Stage (IUS) configuration for launching high altitude satellites is a two-stage, three-axis stabilized vehicle that can deliver up to 2270 kg (5,000 lb) to a geosynchronous orbit.

Will your satellite use an IUS?

Yes ( ); No ( ); Maybe ( )

Will your satellite use a self-contained propulsion system for launch from the Shuttle parking orbit into the operational orbit?

Yes ( ); No ( ); Maybe ( )

INTERPLANETARY MISSIONS

The Interim Upper Stage (IUS) can launch interplanetary missions from Shuttle parking orbits.

A three-stage IUS can inject a 4540 kg (10,000 lb) spacecraft into an escape trajectory for the inner planets.

Will your spacecraft use a three-stage IUS?

Yes ( ); No ( ); Maybe ( )

A four-stage IUS can inject a 540 kg (1,200 lb) spacecraft on a course for the outer planets.

Will your spacecraft use a four-stage IUS?

Yes ( ); No ( ); Maybe ( )

SELF-CONTAINED PROPULSION SYSTEM
Please check (✓) the type(s) of self-contained propulsion system(s) included in your payload.

( ) None
( ) Perigee kick-solid
( ) Perigee kick-liquid
( ) Apogee kick-solid
( ) Apogee kick-liquid
( ) Orbit adjust
( ) Stationkeeping
( ) Other - Explain in "Notes"

SATELLITE/SPACECRAFT SIZE
Please estimate below the envelope size of your payload when it is stowed in the Orbiter cargo bay, *including* any self-contained propulsion systems, but *excluding* the SSUS, IUS, or other STS-provided upper stage(s) required.

Payload Diameter: ________m,
or ________ft

Payload Length: __________m,
or ________ft

SATELLITE/SPACECRAFT WEIGHT
Please indicate below the launch weight range for your satellite or spacecraft. Do *not* include the SSUS, IUS, or other STS-provided upper stage(s) if required, but *do* include the weight of any self-contained propulsion systems.

NOTES:

( ) <454 kg (1,000 lb)
( ) 454 kg to 2270 kg (5,000 lb)
( ) >2270 kg to 4540 kg (10,000 lb)
( ) >4540 kg to 9080 kg (20,000 lb)
( ) >9080 kg to 13,620 kg (30,000 lb)
( ) >13,620 kg to 18,160 kg (40,000 lb)
( ) >18,160 kg to 22,700 kg (50,000 lb)
( ) >22,700 kg to 27,240 kg (60,000 lb)
( ) >27,240 kg

Or, estimate weight, if possible:
__________kg, or ____________lb

PAYLOAD DEPLOYMENT
Payloads using the Interim Upper Stage (IUS) will be deployed from the Orbiter's cargo bay using the Remote Manipulator System (RMS). Payloads using the Spinning Solid Upper Stage (SSUS) will be deployed with spin/tilt tables.

Payloads which do not need an STS-provided upper stage can be deployed by the Orbiter's RMS, or by a special payload-provided device.

The Orbiter provides one manipulator arm capable of deploying payloads weighing up to 29,484 kg (65,000 lb). A second arm can be added when needed.

If your payload does *not* use the IUS or SSUS upper stages, please check (✓) the following, as appropriate.

( ) This payload will or might use a *payload-provided* deployment device.

( ) This payload will or might use *one* RMS arm for deployment.

( ) This payload will or might use *two* RMS arms for deployment.

OPERATIONAL LIFE

The operational life of free-flying payloads ranges from a few months for some scientific investigations to 7 years or longer for commercial communications satellites.

Please check (✓) below the estimated operational life for your payload (i.e., the time that it is expected to operate without servicing or repair).

( ) ≤6 months
( ) >6 to 24 months
( ) >24 to 60 months
( ) >60 to 120 months
( ) >120 months - Explain in "Notes"

ON-ORBIT SERVICING

The Shuttle can provide routine servicing or repair for satellites in low earth orbit. Is on-orbit servicing planned for your payload?

No ( ); Maybe ( ); Yes ( ).

If on-orbit servicing is, or might be required by your payload, please check (✓) the estimated time between servicing flights.

( ) ≤12 months
( ) >12-24 months
( ) >24-36 months
( ) >36-60 months
( ) Other: ____months.

NOTES:

If on-orbit servicing is, or might be required by your payload, please check (✓) below the total time from satellite deployment to decommissioning or to retrieval for return to earth.

( ) ≤24 months
( ) >24 to 60 months
( ) >60 to 120 months
( ) >120 months - Explain in "Notes"

PAYLOAD RETRIEVAL/REUSE

The Shuttle can be used to retrieve satellites from low earth orbit and return them to earth for refurbishment and reuse.

Is retrieval planned for your payload?

No ( ); Maybe ( ); Yes ( ).

If retrieval is, or might be planned, would the same payload be refurbished for subsequent reflight?

No ( ); Maybe ( ); Yes ( ).

If your payload will, or might be retrieved and refurbished for reflight, please check (✓) below the estimated number of times the payload would be refurbished and relaunched.

( ) Once
( ) Twice
( ) 3 or 4 times
( ) 5 or more times

EXTRAVEHICULAR ACTIVITIES (EVA)

The Orbiter provides the systems and personnel needed to perform manual tasks outside the pressurized work area. Nominal resources permit two, two-man EVA's, each lasting six hours.

EVA can be used for resupply; replacement of obsolete or malfunctioned parts; deployment, positioning, retraction of solar cell panels and antennas; etc.

Please check (✓) as applicable:

( ) EVA is *not* needed for the normal delivery of this payload.

( ) EVA *is* needed for the normal delivery of this payload.

( ) EVA is *not* needed for on-orbit servicing of this payload.

( ) EVA *is* needed for on-orbit servicing of this payload.

REMOTE MANIPULATOR SERVICING

The Orbiter provides one 15.24m (50 ft) long remote manipulator arm to perform payload operations outside the pressurized work area.

The arm includes a mechanical hand to grasp and move equipment components. In the manual operating mode, the hand can be positioned linearly to an accuracy of ±3.8 cm (±1.5 in), and rotationally to within 0.5 deg. In the automatic mode, these positioning accuracies are, respectively, ±5.1 cm (±2.0 in) and 5.0 deg.

With the arm fully extended, the maximum force exerted at the tip is 6.8 kg (15 lb). At other arm positions relative to the attach point, this force can grow to 23 kg (50 lb).

There are also a light and a TV camera for remote payload viewing. A second arm can be added for payloads requiring servicing with two arms.

Please check (✓) as appropriate.

( ) Remote manipulator arms will *not* be needed for normal payload operations.

For normal payload operations:

( ) one arm *may* be needed.
( ) one arm *will* be needed.
( ) two arms *may* be needed.
( ) two arms *will* be needed.

NOTES:

CREW TIME

The Orbiter can support a crew of three to seven persons. Three Orbiter crew members will perform Orbiter functions, as well as extravehicular activities and operation of the Remote Manipulator System.

Payload crew members can be flown to perform specialized payload checkout and deployment operations. Each payload crew member can devote about 8 to 10 hours per day to payload operations.

Remembering that payload crew time may be needed for systems activation, checkout and monitoring, please check (✓) the estimated payload crew time required to deliver your payload.

( ) None
( ) ≤ 4 hours
( ) > 4 to 8 hours
( ) > 8 to 24 hours
( ) > 24 to 50 hours
( ) > 50 hours - Explain in "Notes"

DATA MANAGEMENT

The Orbiter communications system provides means to receive data from and issue commands to the payload as well as transmit data to and receive commands from ground stations for 55-70% of the orbital mission.

Orbiter to Ground:
- Digital Data (≤50M bps)
- Analog & TV (≤4.2M Hz)
- Voice

Ground to Orbiter:
- Digital and Command (≤2k bps)
- Voice

Orbiter to Payload
- Digital and Command (≤2k bps)
- Voice

NOTES:

Payload to Orbiter (Pre-release):
- Digital Data (≤50M bps)
- Analog & TV (≤4.2M Hz)
- Voice

Payload to Orbiter (Post-release):
- Digital Data (≤16k bps)
- Voice

Payloads can use the Orbiter's general purpose computer, 14-track analog (≤2M Hz)/digital (≤1M bps) data recorder, and display/keyboard units for data management and on-board monitoring and control of payload checkout and operations.

Are the standard Orbiter data management capabilities sufficient to support the on-orbit checkout and deployment/retrieval of your payload?

Yes ( ); Maybe ( ); No ( ) - Explain in "Notes"

Estimate data management requirements, if possible:

Down Link:
- Digital: No ( ); Maybe ( ); Yes ( ).
- Digital Rate: ______________ bps
- Analog: No ( ); Maybe ( ); Yes ( ).
- Analog Bandwidth: __________ Hz
- Television: No ( ); Maybe ( ); Yes ( ).
- Voice: No ( ); Maybe ( ); Yes ( ).

Up Link:
- Digital: No ( ); Maybe ( ); Yes ( ).
- Digital Rate: ______________ bps
- Voice: No ( ); Maybe ( ); Yes ( ).

On-board
- General Purpose Computer: No ( ); Maybe ( ); Yes ( ).
- Display/Keyboard Unit: No ( ); Maybe ( ); Yes ( ).

Other - Explain in "Notes"

PAYLOAD CONTROL

Payload checkout and monitoring operations can be controlled on-board, or by digital commands issued from the ground. While on-board control can be continuous, ground control will be disrupted for periods of up to 10 mintes every 25 to 40 minutes because of communications blockages.

Please check (✓) as applicable.

- ( ) Payload does not require any control.
- ( ) Payload checkout and deployment requires only "on/off" commands.
- ( ) Payload checkout and deployment requires real-time active control (closed loop).

If real-time active control is required, there are several methods by which it can be accomplished.

Please check (✓) the applicable method(s).

- ( ) By on-board crew
- ( ) By on-board computer
- ( ) By digital command from ground.

NOTES:

COMMUNICATION COVERAGE

Communications contacts between the Shuttle and ground control stations (via the Tracking and Data Relay Satellite System) are dictated by orbit parameters and vehicle attitude. Real-time communications will be possible for 55-70% of the time.

Some payloads may need real-time communication on a *random schedule*. That is, the events that bring on communications are unpredictable.

Some payloads may need real-time communication on a *fixed schedule*; that is, at fixed times into the mission or at fixed (or known) orbital positions.

Some payloads may need real-time communication on a *flexible schedule*. That is, convenient times for communications can be chosen before or during the mission.

For normal operation of this payload, *real-time* communication with the ground:

- ( ) is *not* needed.
- ( ) is or may be needed on a *flexible schedule*.
- ( ) is or may be needed on a *fixed schedule*.
- ( ) is or may be needed on a *random schedule*.
- ( ) Other - Explain in "Notes"

FLIGHT SCHEDULING

Some payloads may require a Space Shuttle launch schedule timed to expose the payload to specific events, environments, or phenomena.

Please check (✓) the launch scheduling factors which must be considered for your payload.

( ) Seasons of the year
( ) Ground target illumination
( ) Solar activity
( ) Phase of the moon or planets
( ) Celestial target viewing
( ) Rendezvous requirements
( ) Other - Explain in "Notes"
( ) None known

PAYLOAD REPLACEMENT

Do you plan to replace this payload at the end of its operational life or upon decommissioning with another similar or identical (but not the same) payload?

No ( ); Maybe ( ); Yes ( ).

If you answered "yes" or "maybe", how many times will, or might, the payload be replaced (not including the initial flight)?

( ) Once
( ) Twice
( ) 3 times
( ) More - Explain in "Notes"
( ) Unknown

If you answered "yes" or "maybe", are the answers given to the questions in pages D-2 through D-8 typical for the replacement payloads?

Yes ( ); No ( ); Maybe ( )

NOTES:

PAYLOAD AVAILABILITY

Please indicate below the development status of your payload.

( ) Development *has not yet begun.*

( ) Development *is underway.*

( ) Development *is complete* and hardware is available now.

If development *has not yet begun,* please check (✓) your best estimate of the time required to design, construct, test and deliver your payload, starting from program approval date.

( ) Less than one year.

( ) One to 2 years.

( ) Two to 3 years.

( ) Three to 5 years.

( ) More than 5 years.

If development *is underway,* please enter below the *earliest* date when your payload could be delivered for integration into the Shuttle.

Delivery Date: __________ Month ________ Year

E. SUPPLEMENTARY INFORMATION

This section is provided for you to add information that is important for a better understanding of your payload element.

Please check (✓) the type of supplementary information you have attached to this questionnaire.

( ) Sketches, drawings, photographs
( ) Payload data sheets
( ) Block diagrams or flow charts
( ) Reference documents or reports
( ) List of reference documents
( ) List/description of mission or accommodation requirements that cannot be compromised
( ) Target list for earth or celestial observations
( ) Description of observational times for earth observations
( ) Other descriptive information is provided on page E-2
( ) No supplementary information is furnished at this time.

Page E-2 provides space for any explanatory text you care to add.

Thank you.

Please use the space below, and additional sheets if necessary, to add any information that you feel is important to defining the mission, spacecraft or other accommodations or environments required by your payload element.

APPENDIX C

Appendix C

ORI
Silver Spring, Maryland 20910

EVALUATION AND FIELD TEST OF PAYLOAD PLANNING DATA SHEETS

- TECHNICAL REPORT -

J. Levy, M. Pasciuto

March 24, 1978

Prepared Under Contract No. P. O. 46-52079
For General Dynamics Convair Division
P. O. Box 80827
San Diego, California 92138

TABLE OF CONTENTS

I. INTRODUCTION AND SUMMARY

In order for NASA to achieve effective long range payload and mission planning, there exists a need for a mechanism to collect payload planning information. To accomplish this objective, an easy to complete set of payload information sheets have been developed. The questionnaire which has been developed is completely self-contained and provides all the necessary instructions, choices and/or space for the appropriate response(s). Two questionnaires were developed; the first for instruments /experiments which do not directly interface with the Shuttle, and the second for Shuttle payload elements. In the development of the payload planning questionnaires, the following criteria were considered: NASA Headquarters and Field Centers needs for program planning and management; the capabilities for providing information on the part of those who will furnish it (potential principal investigators, spacecraft designers, sponsoring centers, and NASA Headquarters sponsoring offices); and the capability to incorporate the data provided into a useful payload planning data bank.

In order to achieve these objectives ORI has performed an evaluation of the initial questionnaire by soliciting comments from the Office of Space Science (OSS), Office of Aeronautics and Space Technology (OAST) and the Office of Space and Terrestrial Applications (OSTA). In addition, ORI

has also evaluated and recommended changes in the questionnaire before its initial use (Ref. 1). Subsequent to the final revisions of the questionnaire, ORI performed a field test, which involved the distribution of the instrument/experiment questionnaires to potential principal investigators in OSTA, OAST and OSS. The completed questionnaires were then evaluated by a series of ORI developed criteria which is explained in detail below. The results of this field test evaluation were then corroborated by follow-up telephone conversations with several of the principal investigators. The conclusions reached by these analyses indicate that: the questionnaire appears to be readily understandable; easy to fill out; and in general the responses provided are accurate and complete. In short the instrument/experiment questionnaire appears to be right on target.

1. Letter from Dr. J. Levy ORI To Mr. J. D. Peterson GDC. 15 Nov. 1977.

II. STUDY APPROACH AND RESULTS

2.1 EVALUATION CRITERIA

In order to adequately evaluate the responses to the questionniares, a set of six criteria were developed by ORI. These criteria addressed the various types of questions in the questionnaire, as well as the content of the replies.

Lead/Author Page The lead page of each respondents questionnaire was checked for completeness and interpretation of the information requested.

Open-Ended Questions Five questions, (on pages B-1, C-5, C-9, C-13, C-16) were of the "open ended" type, that is, the respondent was given the opportunity to write as little or as much as required to adequately answer the query. Since these questions allowed some degree of freedom, they were analysed according to the following three criteria:

1. Typewritten/handwritten (legibility)
2. Frequency and length of response
3. Content analysis

The first criterion (Type/handwritten) is clearly self-explanatory. The second criterion indicates which open ended questions were

answered, how frequently, and with what length. An analysis of the content of each open ended reply was also made so as to check if the respondent understood the query and/or if any future modification should be made.

Marginal Comments In addition to analysing the open-ended questions, ORI checked each questionnaire to determine if the respondent felt the need to add any marginal comments. The use of marginal comments by a respondent may indicate lack of understanding of a particular query or the belief that additional information in his response is required. The marginal comments in each response were noted and checked for content, that is do they indicate a lack of understanding of a query, or do they indicate the need for revised or additional answer selections.

Notes Section At the bottom of each page in the questionnaire a section for additional notes was provided. These spaces allowed the respondents to amplify, where he felt necessary a particular answer. It also provided a chance for the respondent to make comments relating to a particular question.

Query Analysis ORI also checked each questionnaire for any questions which the respondent did not answer. In addition, for those questions answered, checks were made for negative/positive bias in choice selection; added answer choices (may indicate a need for new/revised queries), and the number of "maybe" answers (could indicate a lack of effort or understanding of the query).

Supplementary Information Section The supplementary information section (Section E) provides the respondent with an opportunity for an essentially open ended response, both in length and subject chosen. Detailed answers here on subjects not covered in the questionnaire could indicate potential oversights in the content of the queries. This section was checked for type or handwritten responses, frequency and length of responses and an interpretation of the query (additional needs, understanding etc.).

In addition to analysing the questionnaires according to the above criteria, ORI conducted a brief follow-up telephone interview with each of the responding individuals. The purpose of this follow-up procedure was to get feedback from the respondent on the design, organization and content of the questionnaire. Questions were asked concerning general impression, organization, content and the perceived value and intent of the questionnaire. In addition, the respondents were asked how long it took to complete the form, and would they like to see semi-annual revisions. The respondents were also asked for any criticisms or modifications they would like to see incorporated.

III CONCLUSIONS AND RECOMMENDATIONS

The results of the field test of the questionnaires was overwhelmingly favorable. This is indicated both in the analysis of the written responses and corroborated by discussions during the follow-up telephone interviews. In summary, we conclude that the questionnaires were:

- Well received
- Accurately filled out
- Rapidly filled out and
- Worth while to both the Principal Investigators surveyed and to NASA planners.

An analysis of each questionnaire was performed according to criteria explained in Section II. These results are summarized in Table I. The lead/author page was generally accurately filled out although several of the respondents omitted the date, and discipline. One respondent did not fill in the status of his experiment and one did not know who the NASA Headquarters responsible individual was. The open ended questions on pages B1, C5, C9, C13, and C16 were fairly uniformly answered. All respondents answered the questions on page B1 (Experiment Title, Experiment Objectives, Experiment Description) completely and with fairly long responses. In a follow-up telephone interview, one respondent said he would like to see more space provided for these answers. The open-ended question on page C-5

TABLE I

SUMMARY OF QUESTIONNAIRE FIELD TEST

	OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY (OAST)			
RESPONDENT	I	II	III	IV
A LEAD/AUTHOR PAGE				
1 No. of Items unanswered	1	1	2	2
2. Item(s) Omitted	Date	--	Date, Discipline	Date, Discipline
B. OPEN ENDED QUESTIONS (B1, C5, C9, C13, C16)				
1 Type/Handwritten (Legible?)	Hand-Legible	Typed	Hand-Legible	Typed
2. Frequency & Length of Response(B1, C5, C9, C13, C16)	(Long, -, -, -, -,)	(Long, -, -, -, -)	(Very Long, -, Short, -, -)	(Med., -,-,-,-,)
3 Content Analysis (Understanding, etc.)	Good	Good	Good	Good
C. MARGINAL COMMENTS				
1. Number	5	1	1	4
2 Related Query	C1, C2, C3, C8, E1	C12	C4	B2, C3, C5(2)
3 Content Analysis	Brief, Explanatory Material	Really a Footnote	Brief Note	Indicate Query Irrelevant to His Experiment
D NOTES SECTION				
1 Number	1	2	1	2
2 Related Query	C8	C12, C14	C10	C2, C8
3 Content Analysis	Brief, Relevant	Brief Footnotes	Brief, Explanatory	Medium, Explanatory
E QUERY ANALYSIS				
1. Number Unanswered	0	0	0	2
2 Added Choices (Question No.)	C1, C2, C3	0	0	0
3. Negative/Positive Bias	None	None	None	None
4. Number of "Maybes"	6	5	3	5
F SUPPLEMENTARY INFO. (SEC. E)				
1. Type/handwritten	Hand-Legible	None*	Hand-Legible	None*
2 Frequency & Length of Response	1	--	1	--
3 Content Analysis	Explanatory	--	Explanatory	--

* Respondent indicated material included, but not forwarded to ORI

TABLE I
SUMMARY OF QUESTIONNAIRE FIELD TEST
(Continued)

RESPONDENT	OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS (OSTA) I	OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS (OSTA) II	OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS (OSTA) III	OFFICE OF SPACE SCIENCE (OSS) I
A. LEAD/AUTHOR PAGE				
1 No of Items unanswered	3	1	0	0
2. Item(s) Omitted	Date, Discipline, Status	NASA Hq Individual	--	--
B OPEN ENDED QUESTIONS (B1, C5, C9, C13, C16)				
1 Type/Handwritten (Legible?)	Hand-Legible	Typed	Hand-Legible	Hand-Legible (Many Abbreviations)
2. Frequency & Length of Response(B1, C5, C9, C13, C16)	(Med , -,-,-,-)	(Med , -,-, Med.,-)	(Long, -,-,-,-)	(Long,-,-,-,-)
3 Content Analysis (Understanding, etc.)	Fair	Good	Good	Good
C. MARGINAL COMMENTS				
1. Number	1	0	0	4
2. Related Query	B3	--	--	C4, C5, C7, C15
3 Content Analysis	Does Not Understand "Autonomous"	--	--	Explanatory Material
D. NOTES SECTION				
1 Number	2	3	0	6
2. Related Query	C8, C10	C., C1C, D1	--	C1, C2, C4, C8, C10, C11
3 Content Analysis	Very Brief	Brief, Explanatory	--	Medium length, Explanatory
E QUERY ANALYSIS				
1. Number Unanswered	0	3	0	1
2. Added Choices (Question No.)	0	(	0	C15
3. Negative/Positive Bias	None	None	None	None
4. Number of "Maybes"	3	3	8	2
F. SUPPLEMENTARY INFO (SEC. E)				
1. Type/handwritten	None	None	None	None
2 Frequency & Length of Response	--	--	--	--
3. Content Analysis	--	--	--	--

* Respondent indicated material included, but not forwarded to ORI

concerning pointing accuracy and stability requirements was never answered, and only one respondent filled in a portion of the questions on page C-9 concerning target viewing repetition rate. Only one respondent filled in the envelope drawing on page C-13. None of the respondents provided additional information concerning flight requirements on page C-16. In general, open ended questions were answered only when they were relevant to a particular experiment.

The notes section on each page of the questionnaire also provided respondents with an opportunity to amplify their responses. In general these sections were only used two or three times and most often they were used with questions on pages C-8 (acceleration level and ambient pressure), and C-10 (day-night cycle and flight scheduling). These notes tended for the most part, to be brief explanatory material. In only one questionnaire was the note very long, and in this case (OSS Pages C-1 and C-2) it was used to further define the goals and objectives of the experiment. This was also the respondent who, in the follow-up telephone interview requested additional space on page B-1 to define the objectives of his instrument.

Each questionnaire was also checked for marginal comments which might indicate a need for additional or modified answer selections, or a lack of understanding of the question. Marginal comments were usually very few. Five respondents had one or none, and the remaining respondents had four or five. Usually these marginal comments served as footnotes. In one case (OSTA I) the respondent was unsure of the term " autonomous", and so indicated in the margin. It is also interesting to note here that one respondent was using the questionnaire to describe an entire facility, and he crossed out the word "experiment" throughout his questionnaire and replaced it with the word "facility".

In the analysis of the actual questions answered, most respondents answered all, and the others omitted no more than three. One respondent suggested that either the experiment control time (page C-1), data management time

(page C-2) and real-time communications coverage time (page C-3) selections be made equal, or that the respondent be afforded space to fill in his own. The only other added choice was on page C-15 (OSS respondent) concerning experiment availability. This respondent suggested one more category be added: "development complete, engineering for Shuttle necessary". The number of times a respondent selected "maybe" as a choice was also tabulated, and varied from 2 to 8 times. In none of the cases did this appear to indicate either a lack of effort or understanding.

The final portion of the brochure which was checked was Section E, Supplementary Information. In general this section was little used. Two respondents included hand-written explanatory notes while four indicated no information was provided. In two cases (OAST I & III) there was an indication that supplementary information was attached, but this information was not forwarded to ORI.

In the analysis of the questionnaires, our discussions with NASA Program Offices, and the follow-up conversations with the respondents, we believe that some changes should be made.

The first is that the cover of the questionnaire should read "To Be Used for Planning Purposes Only", and that in Section A it should be clearly indicated that filling out a questionnaire neither guarantees funding or space on a Shuttle flight. In addition, since the person who is mailed the brochure is not necessarily the principal investigator or the person who actually fills it out, another item should be added to the lead/author page allowing the respondent, if he is not the principal investigator to add his name, address and phone number. In the follow-up telephone interviews it was determined that at least half the time the questionnaire was passed along to someone other than it was mailed to. In one case it was sent to a contractor to fill out. Section 4 of the lead/author page "NASA Headquarters Responsible Individual" should be deleted. For experiments in the early planning stages this individual

might not be known. Page B-1 which contains questions concerning experiment objectives and descriptions should have the sample responses moved to after the space provided in the answers.

The question on page C-4 concerning the need for instrument orientation is often misunderstood. Many respondents indicate that they require no instrument pointing, but then continue on and fill out the remaining questions in this section. It is recommended that the branch from page C-4 to page C-1 (if no instrument pointing is required) be made more distinct.

The questions on page C-6 concerning "Contamination Sensitivity" and "Contamination Generation" can be shortened extensively by simply listing the types of possible contamination (particulate, gaseous, radioactive, etc.) and letting the respondent select those applicable. There are several questions scattered throughout the brochure which refer to particular Shuttle/Spacelab options, such as the Remote Manipulator Systems (RMS), a high quality optical window, need for EVA and so forth. It is recommended that these be combined in one area under Shuttle/Spacelab options. One final recommendation is that the question concerning radiation (C-7) is much too detailed, and should be either shortened or completely eliminated.

ORI conducted follow-up telephone interviews with each of the respondents to assess their overall impression of the questionnaire. The respondents indicated that the questionnaire required approximately two hours to complete. The respondents felt that the questionnaire was reasonable, well thought out, and summarized in one place many of the items that they needed to consider in designing their experiments. It was felt that the questionnaire was one of the easiest to fill out of this type, and that it was definitely a worth-while endeavor, and should be continued with some sort of brief summary feedback to the respondents to let them see what other missions were being proposed.

GENERAL DYNAMICS

Convair Division